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THIRD UNITED NATIONS CONFERENCE ON THE EXPLORATION AND PEACEFUL USES OF OUTER SPACE

PREPARATIONS FOR THE THIRD UNITED NATIONS CONFERENCE ON THE EXPLORATION AND PEACEFUL USES OF OUTER SPACE BY THE PREPARATORY COMMITTEE

Note by the Secretariat

The General Assembly, in its resolution 52/56 of 10 December 1997, agreed that the Third United Nations Conference on the Exploration and Peaceful Uses of Outer Space (UNISPACE III) should be convened at the United Nations Office at Vienna from 19 to 30 July 1999 as a special session of the Committee on the Peaceful Uses of Outer Space, open to all States Members of the United Nations. In the same resolution, the Assembly also requested the Preparatory Committee and the Advisory Committee to carry out the preparatory work, including the preparation of the draft report of the Conference by those bodies.

The text contained in the annex to the present note was prepared by the Secretariat on the basis of comments made by the Preparatory Committee at its 1998 session during its paragraph-by-paragraph consideration of the text contained in document A/CONF.184/PC/L.1, which had been prepared by the Secretariat on the basis of advice provided by the Advisory Committee, at its 1998 session for the preparation of the draft report of the Conference. The present revised version of the draft report will be considered by the Advisory Committee at its 1999 session, to be held from 22 to 26 February 1999, so that the draft report can be finalized and forwarded to the Conference for consideration.

Annex

DRAFT REPORT OF THE THIRD UNITED NATIONS CONFERENCE ON THE EXPLORATION AND PEACEFUL USES OF OUTER SPACE

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SUMMARY

I. INTRODUCTION (PARTS I-III)

In the twentieth century, humanity has made significant progress in the development and use of space science and technology to address human needs. At the threshold of a new millennium, the global community is faced with challenges to its sustainable development and is also presented with significant opportunities for scientific and socio-economic development. Global cooperation in space science and technology can help meet those challenges and opportunities.

Since the launch of Sputnik-I in 1957, humankind has sent satellites into orbit to provide daily information on the Earth's weather and data for use in the management of natural resources and disasters and for environmental monitoring, and to provide communication linkages, which have shrunk distances between communities, resulting in greater interdependence among nations. Scientific satellites and orbital platforms have deepened our understanding of the universe, of our planet's place in the universe and of interactions between our Earth and the life-giving Sun.

The United Nations has accorded significant importance to the promotion of greater international collaboration in those areas. The Committee on the Peaceful Uses of Outer Space, established by the General Assembly in 1959, and the Committee's Scientific and Technical as well as Legal Subcommittees have fostered international cooperation in different aspects of space science and technology and their applications, including those for sustainable development. The Assembly has also adopted several treaties and sets of principles, laying the ground rules for the peaceful and fruitful conduct of space activities.

Recognizing the need for a global dialogue on those key issues, the United Nations held two space conferences in Vienna, in 1968 and in 1982. Those conferences led to many new initiatives, including the creation of the United Nations Programme on Space Applications, the expansion of its mandate and the establishment of regional centres for space science and technology education. Such initiatives and others aimed at building in developing countries the human and institutional capacities for understanding and use of space technologies for socio-economic development. Several United Nations agencies have also joined in the efforts to meet those objectives within their respective mandates.

And yet, many challenges remain. Today, continued population growth and unsustainable patterns of production and consumption are putting increasing pressure on the Earth's environment and on scarce natural resources. Each year, natural disasters cause damage in the billions of dollars and claim countless human lives. Improved space capabilities and international cooperation could assist in dealing with those issues and could also enhance economic and social progress. There is also a need to devise more effective mitigation measures against space debris and to improve our understanding of the effects of solar storms.

To address those challenges, and to take advantage of those opportunities, the General Assembly decided in its resolution 52/56 of 10 December 1997 to convene the Third United Nations Conference on the Exploration and Peaceful Uses of Outer Space (UNISPACE III) in Vienna from 19 to 30 July 1999, under the theme "Space Benefits for Humanity in the Twenty-First Century". The Conference is an invitation to the international community to take stock of the significant developments that have taken place since 1982, including geopolitical changes, numerous scientific and technological advances, the contributions of new "space-faring" nations and the important role of the private sector. Accordingly, the primary objectives of the Conference are:

- To promote the effective means of using space solutions to address problems of regional or global significance;

- To strengthen the capabilities of Member States, especially developing nations, to use the results of space research for economic and cultural development.

UNISPACE III presents a unique opportunity for the world's experts and decision makers to meet and exchange information and ideas to advance the human condition into the next millennium.

II. HARNESSING THE POTENTIAL OF SPACE AT THE START OF THE NEW MILLENNIUM (PART IV)

A. Protecting the environment

1. Scientific knowledge of Earth and its environment

Planet Earth is facing the increasing threats of rapid environmental changes, including climate change and its attendant consequences, deforestation, desertification and land degradation, further depletion of the ozone layer, acid rain and a reduction in biodiversity. Such changes would have a profound impact on all countries, yet many important scientific questions remain unanswered.

Satellites can provide the synoptic, continuous and long-term global observation needed to understand the Earth's system more comprehensively, in conjunction with the use of modelling technology, to address issues such as (a) the influence of the Sun on the Earth's environment; (b) global climate change; and (c) impacts on the environment and human health caused by anthropogenic activities and changes in the ozone layer.

2. Environment and natural resources and remote sensing

Weather forecasting, disaster management and the management of Earth's resources are areas where remote sensing is contributing successfully to the improvement of the human condition. Reliable weather forecasting and longer-term climate predictions have become an essential part of our daily life. Satellites increasingly provide important information for early warning and management of the effects of disasters and information that is useful in the management of agriculture, forestry, minerals, water resources and fisheries. All these applications need continuous data acquisition and will benefit from improvements in remote sensing technologies and associated data analysis.

Measures should be taken to maximize the benefit of remote sensing systems through increased availability and affordability of data and information products; improved provision of technical information, training and financial support for developing countries to understand and use remote sensing data and derived information; improved understanding on the part of decision makers of the importance and usefulness of remote sensing data and derived information in the development process; and improved coordination among ongoing and planned programmes and initiatives to eliminate duplicated efforts and to identify gaps.

B. Facilitating and utilizing communications

Communications and broadcast satellites have progressed from small, low-power satellites with low-gain antennas to large complex platforms with high transmission power, precise pointing, a very high frequency reuse and longer design life. Such technological advances have led to a progressive emergence of new telecommunications services and applications. Newly proposed or enhanced satellite services include mobile telephony, data, imaging, video teleconferencing, digital audio, multimedia and global Internet access. Wide-ranging applications being planned include distance learning, corporate training, collaborative work groups, telecommuting, telemedicine, electronic commerce, direct-to-home video and satellite news-gathering, as well as the distribution of music, software, scientific data and global financial and weather information.

Rapid advances in communications and information technologies have had many positive effects, but have also widened the gap between those who can use those technologies to access more information more quickly and those who cannot. New satellite communications systems can reduce that information gap. In addition, countries with poor communications and information infrastructures should consider establishing legislative and regulatory frameworks, assessing how space technology can meet their information and communications needs and investing in telecommunications infrastructure accordingly.

C. Improving and using position/location capabilities

There are currently two global satellite navigation systems, the Global Positioning System (GPS) of the United States of America and the Global Orbiting Navigation Satellite System (GLONASS) of the Russian Federation. The use of transmitted signals to determine position, velocity and time from these military systems has been offered free of charge to civilian users. The services are used largely in the field of transport, but new applications, such as in meteorology and geology, and geographical information systems (GIS), have emerged. With a view to further developing the capabilities of such systems, Europe is implementing the European Geostationary Navigation Overlay System (EGNOS) and will consider a follow-up system, the Global Navigation Satellite System-2 (GNSS-2). Full acceptance of such systems as navigation aids will be influenced by the guarantee of open access and continuity for civilian use and the enhancement of the system through overlay or augmentation. A large degree of regional and global cooperation is essential to achieve a seamless multimodal satellite-based radio navigation and positioning system throughout the world.

D. Furthering knowledge and building capacity

The ability to develop and use space science and technology depends critically on the availability of human resources with appropriate knowledge and skills. Research, education and training are the cornerstones for furthering knowledge and are part of the overall capacity-building process. In addition, capacity-building includes establishing policies, establishing institutional frameworks and physical infrastructures, ensuring funding support and gaining experience, the latter by undertaking research and operational activities. A key element of the effort to build such capacities in the developing countries is the establishment, under the auspices of the United Nations Programme on Space Applications, of the regional centres for space science and technology education. Those centres should be endowed by the United Nations with appropriate financial and other support.

E. Enhancing education and training opportunities for youth

Planning of space activities should be accompanied by appropriate long-term strategies for human resource development, with emphasis on the cross-cultural experience and interdisciplinary training of future decision makers and managers in space activities. While educational activities are already undertaken for young people in some countries by space agencies, the United Nations and others could provide educational and training opportunities for students and young scientists and engineers. Efforts should also be strengthened to provide young people with opportunities to express their unique and innovative ideas and visions for space activities.

Accordingly, UNISPACE III extends invitations to young space professionals to express their visions and perspectives on future space endeavours.

[Summary of section (e), "Visions and perspectives of youth", could be inserted.]

F. Information needs and the global approach

Information technology includes a cluster of technologies in the field of computing, software, microelectronics, telecommunications, databases and networking. Information systems are fundamental tools for organizing, handling and integrating data through appropriate algorithms and generating information in the form that is most suited to the intended user group. They are valuable for monitoring events, for research and applications, for education and training and for decision-making. Information infrastructures are essential elements of development in any country. Space technology is a potent tool for gathering information and for communicating it rapidly and efficiently over wide and remote areas.

However, many developing countries have not yet established information infrastructures and thus lack access to information as a basic resource for development. It is critical for those countries to invest in building up their national information infrastructure. Furthermore, the resolution of environmental and other issues at the global and regional levels will require a greater integration of national information networks into regional and global ones. This can be facilitated by the use of appropriate space technologies and by the adoption of common standards, distributed networks and common user interfaces.

G. Spin-offs and commercial benefits from space activities—promoting technology development and exchange

Products and services derived from space technology have improved the quality of life all over the world in countless ways. Space research and development promotes and incorporates innovations in many high-technology areas, such as computer software and hardware, advanced electronics and materials, telecommunications, health sciences, remote sensing, launch services and satellite manufacturing. Other major beneficiaries from space technology investments and spin-offs include transportation, environmental monitoring, public safety and computer and information technology sectors.

Space agencies are increasingly entering into partnerships with the private sector for the attainment of their programme objectives. Furthermore, commercial firms have become the primary investors in certain parts of the space market, such as satellite telecommunications. Next to telecommunications, remote sensing and geographic information systems may be among the most significant areas for commercial space activities. Directly and indirectly, space technology is now used by thousands of companies worldwide to bring new products, processes and services to the world market and at ever lower, more affordable prices.

For developing countries, relevant space-related technologies can be used to address social and economic problems successfully. However, notable barriers to the transfer of such technologies exist and include development and acquisition costs, weak infrastructures, lack of defined government policy and support and limited private investment and training opportunities in developing countries. By successfully addressing those issues, developing countries would create a more favourable environment for and a greater use of space technologies.

H. Promotion of international cooperation

In its resolution 51/122 of 13 December 1996, the General Assembly reaffirmed the commitment of Member States to promote international cooperation in the exploration and peaceful uses of outer space for the benefit and in the interest of all States, taking into particular account the needs of developing countries. The fading away of cold war tensions has dramatically altered the way in which the space-faring nations conduct space activities. They and other countries have come to recognize both the advantages of working together to identify common goals and the need to optimize their financial and other resources. A good example is the International Space Station, the largest cooperative international space project to date, by which the participating nations will be able to enhance opportunities for accelerating breakthroughs in technology and engineering as well as for finding new drug treatments for various diseases, by performing long-duration research in materials and life sciences and medical research in a micro-gravity environment.

In view of their universal importance, environmental monitoring and disaster management may be two of the areas where the potential is greatest for enhancing international cooperation. In order to promote cooperation at all levels, the use of the following mechanisms should be enhanced: international intergovernmental and non-governmental organizations and arrangements, ad hoc inter-agency mechanisms, bilateral and regional agreements, programme-specific agreements and transnational commercial activities. International space law as developed by the United Nations through the Committee on the Peaceful Uses of Outer Space reflects the importance of and provides the framework for international cooperation. So far, the United Nations has drawn up and approved five treaties and five sets of legal principles on matters relating to the peaceful uses of outer space. However, most Member States have not yet signed or ratified the various legal instruments governing space activities.

To develop political support for international cooperation in space activities, there should be multilateral consensus on common space goals at the highest decision-making level. To enhance its role in promoting international cooperation in the peaceful uses of outer space, the United Nations should ensure that the agenda of the Committee on the Peaceful Uses of Outer Space and its subcommittees reflect the full scope of issues of relevance to contemporary space activities. Steps should also be taken to improve the coordination of space activities within the United Nations system. The full implementation of those activities by the United Nations and Member States will promote the peaceful and fruitful exploration and utilization of outer space for the betterment of this and future generations.

I. BACKGROUND

A. Historical perspective

1. The interest of humankind in space dates back to prehistoric times. To primitive cultures, invisible beings and influences in the night sky were thought to govern events on Earth. Many of the historic monuments from thousands of years ago were created to worship the Sun, the Moon or other celestial bodies, providing perceived links between the souls on Earth and the spirits dwelling in the heavens.

2. Assisted by telescopes and other optical instruments, humans began to increase their knowledge about the motions of the planets and their understanding of the universe. They started to wonder about their place in the entire scheme of things and to think about the structure, and eventually the origin and the future, of the universe. The science of astronomy became one of the most intellectually stimulating branches of the human quest for knowledge and understanding.

3. The quest for knowledge of the universe was accompanied by a desire to break free from the confines of the planet and to step out into outer space. Following the invention of gunpowder and fire arrows a thousand years ago in China, the idea of travelling by means of rockets slowly crystallized in the human mind. At the end of the nineteenth century, a number of scientists, inspired by works of science fiction about space travel, dreamed about space exploration and began to work on rocket technology.

4. The development of rockets was accelerated by the desire to acquire more effective weapons during the Second World War. It was continued mainly through military research and development. Nevertheless, the first rocket to leave the planet was not used for military purposes. It was used to launch a satellite for the advancement of science on the occasion of the International Geophysical Year, 1957-1958. In October 1957, the successful launch of Sputnik-1 marked the dawn of the space age and the beginning of human efforts to ensure the peaceful uses of outer space.

5. During the early years of the space age, the desire to explore outer space was fuelled by the competition between the two space Powers, resulting in the rapid pace of human achievements in outer space. In April 1961, Yuri Gagarin became the first human being to orbit the Earth. In July 1969, the so-called race to the Moon culminated in the successful lunar landing by Apollo 11, when Neil Armstrong and "Buzz" Aldrin stepped onto the surface of the Moon. The rivalry increased the human capacity to build complex space systems, involving not only advances in science and technology, but also the improvement of system management capabilities.

6. Rapid progress in the development of science and technology systems, including management of large-scale scientific enterprises, made it possible to conduct closer observations of the planets, in both the inner and outer solar systems. To date, all the planets in the solar system, except for Pluto, have been visited by spacecraft. An international armada of scientific spacecraft was also sent to study Halley's Comet on its most recent visit to the inner region of the solar system, an event that occurs at intervals of about 75 years. Together with observations made through the Hubble Space Telescope, providing clear images of celestial phenomena, various missions sent to probe different aspects of the universe will continue to provide clues about the origin and the future of the cosmos and of humankind.

7. Significant progress in the development of space science and technology and their applications have enabled humans to exploit the last frontier, outer space. Efforts to utilize the space environment were further strengthened during the post-Apollo period. Space stations and platforms have provided opportunities to conduct various research activities in orbit. Applications satellites have provided the capability to observe Earth from space and facilitated communications around the world, with momentous consequences for the economic and social development of humankind.

8. In the information age, communications satellites have contributed to the expansion of commercial activities, a promising sign for the growth of space industry in other fields. Launch services are being transferred to the private sector, stimulating efforts to provide access to outer space at lower cost. An increasing volume and variety of remote sensing data and higher-resolution imagery are being disseminated by commercial distributors for various uses.

9. Space technology and its applications have also provided the means of obtaining, through the use of Earth observation satellites, essential data for scientific research on the state of planet Earth. Those satellites will assist humanity in assessing the consequences of industrial activities, thus making it possible to take corrective action to protect the fragile planet.

10. Scientific exploration of outer space, utilization of the near-Earth environment and observation of Earth have enhanced human awareness of the profound interdependence of all people on planet Earth. The global networks created by communications satellites have brought together people around the world, enabling them to exchange ideas freely and to discover their cultural diversity. Data and information on the global environment have demonstrated the vulnerability of the planet to human activities and have increased awareness of the need to join efforts to protect the planet for future generations.

11. The exploration and peaceful uses of outer space promote mutual understanding through cooperation to solve global problems on Earth and to expand human civilizations into outer space. International cooperation in outer space marked another milestone in 1998 with the beginning of construction of the International Space Station, a further step towards fulfilment of the dream of living in space and probing ever more deeply into outer space in the future.

12. Through space exploration, humanity will continue to search for the origin of the universe and for the means of ensuring the future of human civilizations. Through applications of space science and technology, humanity will seek to enhance the human condition, preserve the global environment and ensure global prosperity for coming generations.

B. The United Nations and the peaceful uses of outer space

13. The United Nations has been involved in space activities since the very beginning of the space age. Following the launch of the first man-made satellite, Sputnik-1, in October 1957, in the midst of the cold war, there was a growing concern in the international community that space might become yet another field for intense rivalries between the superpowers or would be left for exploitation by a limited number of countries with the necessary resources. In the following year, the General Assembly established the Ad Hoc Committee on the Peaceful Uses of Outer Space, composed of 18 members, to consider the activities and resources of the United Nations, the specialized agencies and other international bodies relating to the peaceful uses of outer space, organizational arrangements to facilitate international cooperation in the field within the framework of the United Nations and legal problems that might arise in programmes to explore outer space.

14. The Committee on the Peaceful Uses of Outer Space was established as a permanent body in 1959, with a membership of 24 States. Its membership currently consists of 61 States.[1] Following intense consultations among its members, the Committee agreed in March 1962 to conduct its work in such a way that it would be able to reach agreement without voting.

15. In response to a request by the General Assembly in 1961, the Committee has been serving as a focal point for international cooperation in the peaceful exploration and use of outer space and carrying out its mandates to maintain close contact with governmental and non-governmental organizations concerned with outer space matters, to provide for the exchange of information relating to outer space activities and to assist in the study

of measures for the promotion of international cooperation in those activities. The work of the Committee has been assisted by its two subcommittees of the whole, the Scientific and Technical Subcommittee and the Legal Subcommittee, since they were established by the Committee in March 1962. Over the years, those bodies have established working groups on various issues of particular significance.

16. Since the establishment of the Committee and its subcommittees, the practice had been to maintain the same officers, elections taking place only on an ad hoc basis when an officer became unable to continue in office. The various functions had been distributed between the Group of 77, the Group of Western European and Other States and the Group of Eastern European States. In 1996 and 1997, against dramatic geopolitical changes in the post-cold-war period, the Committee reviewed its working methods, including the composition of its bureau. As a result, the Committee agreed to introduce the principles of equitable geographical representation and rotation in the composition of the bureaux of the Committee and its subcommittees, shortened the duration of sessions of those bodies and strengthened the agenda of the Legal Subcommittee. The five offices of the bureaux of the Committee and its subsidiary bodies,[2] each having a term of three years, now rotate among the five regional groups, one office being allocated to each of the following groups of States: Africa, Asia and the Pacific, Eastern Europe, Latin America and the Caribbean and Western Europe and Other.

17. Secretariat services to the Committee and its subsidiary bodies are provided by the Office for Outer Space Affairs, which consists of two sections: the Committee Service and Research Section and the Space Applications Section. The Office is also responsible for the implementation of the United Nations Programme on Space Applications.[3]

18. The discussions and recommendations of the Committee have led to the formulation and adoption of the five multilateral treaties and five declarations and sets of legal principles (see paras. 302-311 below). In addition to the progressive development of the legal regime governing space activities, the work of the Committee has contributed significantly to the promotion of international cooperation in the field of space science and technology. Through the exchange of information on developments in space activities, the Committee has provided Member States with opportunities to identify areas for further cooperation. The Committee has also provided important guidance for the implementation of the United Nations Programme on Space Applications, which has contributed to increasing the capability of developing countries in the utilization of space technology and its applications, through its educational and training activities, and has often served as a coordinator or facilitator for cooperation between developed and developing countries, through its technical advisory services.

19. The work of the Committee has also led to the convening of three United Nations conferences. As early as 1959, the General Assembly decided to convene an international conference, under the auspices of the United Nations, for the exchange of experience in the peaceful uses of outer space and requested the Committee to work out proposals with regard to the convening of such a conference. During the following years, the Committee conducted preparatory work and the Conference on the Exploration and Peaceful Uses of Outer Space was convened at Vienna from 14 to 27 August 1968 to examine the practical benefits of space exploration and the basis of scientific and technical achievements, as well as the opportunities available to non-space-faring States for international cooperation in space activities, with special relevance to the needs of developing countries.[4]

20. One of the results of the Conference was the establishment of a post of Expert on Space Applications, whose full-time task is to promote practical applications of space technology. One of the first recommendations made by the Expert on Space Applications to the Committee was the establishment of the United Nations Programme on Space Applications. In the following year, the General Assembly requested the Secretary-General to allocate a budget for the implementation of the Programme.

C. The Second United Nations Conference on the Exploration and Peaceful Uses of Outer Space

21. In November 1978, on the basis of a recommendation by the Committee, the General Assembly decided to convene the Second United Nations Conference on the Exploration and Peaceful Uses of Outer Space (UNISPACE 82).[5] The Assembly designated the Committee as the Preparatory Committee for the Conference and the Scientific and Technical Subcommittee as Advisory Committee to the Preparatory Committee.

22. The Conference, convened at Vienna from 9 to 21 August 1982[6] and attended by 94 Member States and 45 intergovernmental and non-governmental organizations, considered the state of space science and technology, applications of space science and technology, international cooperation and the role of the United Nations. The recommendations and conclusions of UNISPACE 82, adopted by consensus, are contained in the report of the Conference (A/CONF.101/10 and Corr.1 and 2).

23. The General Assembly, in December 1982, endorsed the recommendations of UNISPACE 82, one of the most significant consequences of which has been the strengthening and expansion of the United Nations Programme on Space Applications. The Assembly decided that the Programme should promote greater exchange of actual experiences with specific applications and greater cooperation in space science and technology between developed and developing countries, as well as among developing countries, and stimulate the growth of indigenous nuclei and an autonomous technological base in space technology in developing countries. In order to achieve those goals, the Programme was requested to develop a fellowship programme for in-depth training of space technologies and applications specialists and to organize regular seminars on advanced space applications and new system developments for managers and leaders in space applications and technology development, as well as for users. The Programme was also directed to disseminate, through panel meetings and seminars, information on new and advanced technology and applications and to provide technical advisory services on space applications projects. An International Space Information Service was also created to facilitate access to data banks and information sources.

24. Following the recommendations of UNISPACE 82, the United Nations Programme on Space Applications translated the elements of its expanded mandate into operational activities in space science and technology, in particular for the benefit of developing countries. During the period from 1971 to 1997, the Programme organized 143 workshops, training courses and meetings of experts, which benefited approximately 7,500 participants. Following up on the recommendations of some of the workshops, the Programme focused on education and training and in particular on establishing regional centres for space science and technology education, affiliated to the United Nations, in each of the economic regions.

25. In 1987, the Working Group of the Whole to Evaluate the Implementation of the Recommendations of the Second United Nations Conference on the Exploration and Peaceful Uses of Outer Space (UNISPACE 82) was established in the Scientific and Technical Subcommittee. The objectives of the Working Group are to improve the execution of activities relating to international cooperation, in particular those included in the United Nations Programme on Space Applications, to propose concrete steps to increase such cooperation and to make such cooperation more efficient.

26. The recommendations made by the Working Group of the Whole since 1987 have focused the attention of the international community on a number of issues of importance to promoting the access to and use of space technology by all Member States, in particular for the benefit of developing countries. At its 1997 session, in concluding its evaluation of the implementation of the recommendations of UNISPACE 82, the Working Group noted that it had refined or interpreted several of the recommendations to make them more specific and to facilitate their implementation. As a result, significant progress had been made, especially in the enhancement of international and regional cooperation in the continued development of worldwide space activities and the

promotion of a greater exchange of actual experiences. Concrete results had been achieved in the following areas: the organization of a fellowship programme of in-depth training courses and workshops on advanced applications of space science and technology; preparation of a series of technical studies relating to specific areas of space science, space technology and their applications; and the establishment of regional centres for space science and technology education. The work of the Working Group had also led to more appropriate allocations from the United Nations budget for the expanded activities of the United Nations Programme on Space Applications. Although many positive actions had resulted from the more than 200 recommendations made by UNISCPACE 82, it was still felt that many others remained unaddressed. That situation was felt to be not conducive to constructive work by the Committee.

27. The Working Group of the Whole has been instrumental in the conceptual development and planning of the Third United Nations Conference on the Exploration and Peaceful Uses of Outer Space (UNISPACE III) and has contributed effectively to the detailed preparatory work on various matters, including the objectives, form, venue, date, participation, provisional agenda, financial aspects and additional components of the Conference.

II. ENABLING ENVIRONMENT FOR SPACE EXPLORATION AND UTILIZATION

A. New international context

28. Since 1982, when UNISPACE 82 took place, there have been a number of new developments in space science and exploration and in space technology. Applications and uses of space technology have rapidly forged ahead, with new technologies and techniques spawning both greater use and increased effectiveness of existing applications, as well as creating new applications worldwide. The number of countries with space capabilities has increased and there has also been a rapid growth in the number of countries that utilize space technology. Major advances have been made in better space-based observations of the Earth's atmosphere, oceans, land surface and biosphere.

29. A major trend, indicative of the success of space technology, is the increasing commercialization of certain applications and the privatization that has emerged. That trend has brought in the entrepreneurial drive and the market acumen of the private sector, giving a further impetus to the growth of space applications. At the same time, the growing market has spurred further initiatives and investment in the development of technology. The public sector is establishing partnerships with the private sector in various phases of the research and development process, giving leverage to the resources of both partners and promoting commercial activities with strong economic growth.

30. The biggest change, however, has been in the geopolitical context. The world has moved from an era of near confrontation to one of cooperation, with growing commercial competition. Clearly, the change in the geopolitical context goes beyond space and affects a whole range of relationships between States. It does have an important impact on space, however, which is likely to manifest itself through many more cooperative/collaborative projects.

31. There are many areas where collective efforts should be made to achieve common objectives of mankind. One of those objectives is to maintain optimal interactions with nature. Since the beginning of civilization, mankind has lived in a competitive relationship with nature. While human interdependence with the environment is widely acknowledged, the relentless pursuit of progress, comfort and security has resulted in constantly increasing stress on the environment, at both the local and global levels. Consequently, the life-sustaining environment of Earth is undergoing a more rapid transformation than ever before. The rapid growth of population, with the resulting expansion of human activities, in particular industrial activities, and the increasing demands to meet the basic needs of people continue to have an adverse impact on the environment. Consequences include the overexploitation of natural resources and the degradation of both the environment and living conditions. There is a growing concern worldwide for land and coastal degradation, air and water pollution, loss of biodiversity and deforestation. Explosive population growth combined with the limited availability of land could cause haphazard urban growth, resulting in the further aggravation of living conditions, exemplified in the proliferation of slums and diseases. Some of the climate changes, such as global warming and depletion of the ozone layer, that could ultimately lead to an ecological crisis affecting the entire biotic species on the planet are considered to be caused, at least in part, by anthropogenic activities.

32. While humans have developed the capacity to alter the state of the surrounding environment, they themselves are still vulnerable to the forces of nature. The damage caused by natural phenomena to people and the productive infrastructure of countries has risen steadily. Besides human and economic losses, disasters can also destabilize social and political structures. The phenomenon known as El Niño, an abnormal state of the ocean-atmosphere system in the tropical Pacific, has important consequences for weather conditions worldwide and could result in global losses of billions of United States dollars ($) and countless human lives. Unusual climate extremes, such as ice storms, floods and drought, could also cost billions of dollars worth of damage per year. Worldwide, the health of more than a billion people is affected each year by vector-borne diseases.

Some of those diseases cause chronic suffering and disability. Many vector-borne diseases are sensitive to weather variability and global climate change. Improved satellite monitoring of the atmosphere, land surfaces, coastal zones and oceans have already demonstrated their value in the prediction of malaria, cholera and other diseases.

33. The challenges posed by the need to reduce the impact of human activities on the environment and to minimize the damage wreaked by natural hazards on societies are being faced by people in all parts of the world. Scientific and technological developments in the twentieth century have increased the human capacity to take collective action at the global level and to ensure human prosperity into the twenty-first century.

34. Space science and technology, together with advances in information technology, have had a profound impact on the day-to-day life of common people. Distances have shrunk and satellite communications have led to the emergence of the global village, where voice, text, graphics and complex instructions can be transferred from one place to another, over large distances, within an extremely short time. Developments in communications science and technology have changed the character of business, national and international transactions, revolutionized economics and banking, transformed the entertainment industry and touched many facets of people's day-to-day life. Satellite-derived data have made it possible to detect the onset of calamities, to monitor the changes that are happening on the face of Earth and to gain an insight into the complex state of the planet. The prediction of weather and changes in climate systems has also helped in the implementation of appropriate agricultural practices, disaster relief, damage mitigation and the forewarning of catastrophic climate events.

35. The challenge lies in increased cooperation at the international level and the sharing of technologies and applications, thus maximizing the benefits accruing from the use of space technology. One critical sphere for international cooperation is the use of space techniques for environmental monitoring and protection. There is now international recognition of the seriousness of the problems of environmental pollution, soil degradation and deforestation, as well as of the issues associated with global climate change. Following the adoption of Agenda 21 at the United Nations Conference on Environment and Development in 1992, a number of initiatives have been taken, including the use of space science and technology for monitoring the environment. International scientific assessments by the Intergovernmental Panel on Climate Change and the third session of the Conference of the Parties to the United Nations Framework Convention on Climate Change, held in Kyoto, Japan, from 1 to 10 December 1997, highlight actions that need to be taken with a view to implementing the United Nations Framework Convention on Climate Change.

36. The evolution of science and technology since UNISPACE 82, the new political climate, reduced public spending and the large number of new participants, including several developing countries and the private sector as major players, require that policy and decision makers in the public and private sectors, in particular in developing countries, take stock of the current importance of space technology applications. Space technology will have important effects on the quality of life of the average person, both in economic and social terms. There will be significant opportunities for economic and social development arising from the projected trends in the growth and development of the space industry. Space activity will become a world economic engine in the twenty-first century, with many opportunities, in particular for developing countries. Space technology can also contribute to reducing the gap between developed and developing countries.

37. In summary, the new context provides a positive framework for the continuing development of space technology and its more extensive applications in existing and new fields. At the same time, the increased commercialization and privatization of space activities has brought in new dynamism, new investments and greater market responsiveness. The new context is also conducive to the further growth of international cooperation in space. The issues dealt with, the discussions held and the recommendations made by UNISPACE III should be placed in that context.

B. Important and growing role of space activities

38. Since the beginning of the space age, space exploration and exploitation have yielded tremendous scientific as well as economic and societal benefits for mankind. Space science provides a wealth of information about the processes that formed the universe, the planetary system, the Sun and Earth itself. Using powerful telescopes, scientists are probing back in time to the very origin of the universe, just moments after the big bang. Humanity is now exploring Mars, Jupiter and Saturn from close range. Current satellites with sophisticated instrumentation will send data back to Earth from which scientists will map the surfaces of the planets and determine the composition of their atmospheres and other geophysical parameters. With such data, energy exchange mechanisms for planetary atmospheric models are being developed and refined.

39. Space technology and its applications have been widely recognized as one of the major instruments for enhancing human ability to understand the environment and manage natural resources and for providing effective communications across long distances and to rural areas. That ability has promoted economic, cultural and social development, in particular for developed countries, and provided the possibility for those countries to accelerate their development process.

40. Earth observation satellites provide an important and unique source of information for studies of the Earth's system. There are currently over 45 satellite missions operating and some 70 more missions, carrying over 230 instruments, are planned for operation during the next 15 years by the world's civil space agencies. These satellites provide measurements of many parameters critical to monitoring the Earth's system. Planned missions will provide a significant increase in data and information over that provided by the satellites currently in operation. Data from existing and future satellites will be used to address issues of social and economic importance, in such areas as land-use management, the management of renewable and non-renewable resources, disaster management, global health and agricultural and fisheries management. Thus, an extremely valuable tool is already available and will be greatly improved over the next decade. The elements of that tool, however, require international coordination, clear definitions of the problems to which they can be applied and, above all, a much broader awareness on the part of its potential users, in particular, developing countries.

41. Although still considered an emerging technology in commercial terms, remote sensing has evolved from traditional applications such as cartography, hydrology, surveying and monitoring of natural resources to more consumer-oriented applications such as disaster preparedness, insurance claims adjustments, marketing, delimitation and appraisal of real estate properties and precision farming. Value added services offered by the private sector in converting the satellite images to meaningful information for the user domain is a growing market, with an estimated value of $600 million over the next five years.

42. Satellite communication systems, including those developed nationally by governmental or commercial entities as well as through international organizations such as the European Telecommunications Satellite Organization (EUTELSAT), the International Mobile Satellite Organization (INMARSAT) and the International Telecommunications Satellite Organization (INTELSAT), have introduced improved techniques and new technologies. The emerging new services would provide more efficient solutions, in both developed and developing countries, for dealing with issues of regional and global concern, such as improving opportunities for education, ensuring access to adequate medical services, increasing the effectiveness of disaster warning and relief operations and developing adaptation or mitigation strategies in relation to climate change.

43. Satellite communications will further develop as an economic engine for both developed and developing countries. The world market for launchings and the operation of satellites for fixed communications and broadcasting alone for the period 1997-2005 is conservatively estimated at between $60 billion and $80 billion. The estimated value of ground station, terminal market and end-user services of those satellites for the same period amounts to an additional $200 billion to $300 billion. While satellite launchings and operations are

limited to space-faring States and large companies, participation in ground-segment activities is open to a much broader range of actors, including those in developing countries.

44. Meteorological and Earth observation satellites form a truly international network that views the Earth on a continuous basis. They provide the data for short- and medium-term weather forecasts (contributing to better planning of agricultural strategies and of a host of daily activities), while the advance warning they give on hurricanes and typhoons has dramatically reduced losses in terms of infrastructure and human life in the large number of countries that are prone to such disasters.

45. Satellite positioning systems such as the Global Positioning System (GPS) and the Global Orbiting Navigation Satellite System (GLONASS), originally deployed for strategic military purposes, now provide non-encrypted signals, free of charge, for civilian applications such as air, land and nautical navigation. GPS receivers allow pilots, drivers and other users to locate objects to within 100 metres. Through the use of differential global positioning techniques, positions can be determined to within 1 metre. That ability is already resulting in greater safety, lower costs and greater productivity for the end-user. In 1994, GPS services and equipment for mapping and surveying and other applications generated combined revenues of $500 million. Those applications and the benefits derived from their use are expected to grow exponentially in the coming decade.

46. With an estimated $77 billion in revenues and employing more than 800,000 people worldwide in 1996, the global space industry has become one of the largest industries in the world. Commercial utilization of space hardware, including telecommunications facilities, and the development of infrastructure elements, such as the manufacture of launch vehicles, satellites and ground equipment, currently represent 53 per cent of the industry, with the balance coming from government financing. In 1996, for the first time, commercial revenues surpassed government expenditures.

47. In order to maximize the benefits of space technology and its applications, in particular for developing countries, at least two interrelated general issues relating to the utilization of advanced technology for economic and societal development should be borne in mind. The first issue concerns promoting the technology to be utilized and understanding the associated problems encountered in its use; the other concerns ensuring the effective utilization of the knowledge of advanced technology for sustainable development activities. Consideration of those issues would enhance overall understanding of the technical, technological and managerial issues as well as the policy implications involved in the use of space technology, thus generating greater scientific, economic and societal returns from space exploration and exploitation, which have already been confirmed in many areas of human endeavour.

III. THIRD UNITED NATIONS CONFERENCE ON THE EXPLORATION AND PEACEFUL USES OF OUTER SPACE

A. Genesis of and preparations for the Conference

48. At its 1992 session, the Committee on the Peaceful Uses of Outer Space noted the proposal that a third UNISPACE conference should be organized in 1995, preferably to be held in a developing country. That proposal was made with a view to consolidating the momentum provided by activities conducted on the occasion of the International Space Year during 1992 and to refining follow-up actions and mechanisms further in order to broaden the scope of international cooperation as well as to promote increased participation of all developing countries in space activities. Based on the recommendation of the Committee, the General Assembly, in its resolution 47/67 of 14 December 1992, recommended that Member States might discuss, during the 1993 session of the Committee, the possibility of holding a third UNISPACE conference.

49. At its 1993 session, the Scientific and Technical Subcommittee, through its Working Group of the Whole, noted the above recommendation of the General Assembly. The Working Group noted that there had been considerable advances and changes in space technology and applications since 1982, as well as many changes in the geopolitical and economic situations affecting space programmes around the globe, and recommended that it could be useful to examine the feasibility of a third UNISPACE conference. In that regard, the Working Group also recommended that the Committee, in addressing the question of such a conference as recommended by the General Assembly, consider the objectives and goals of the conference, as well as questions of organization, venue, timing, financial implications and other matters. The Working Group noted the proposals that a third UNISPACE conference should be held in a developing country in the near future, that it could be held in 1995 and that the Working Group could serve as preparatory committee for it.

50. At its 1993 session, the Committee on the Peaceful Uses of Outer Space observed that the most important step was to define a set of sharply focused objectives for such a conference and that the goals set for it might also be achieved through other means, such as intensification of work within the Committee.

51. During the following years, various ideas and proposals were submitted by Member States, the Chairman of the Committee and its secretariat, upon requests by the Committee and its subsidiary bodies. Those ideas and proposals concerned, *inter alia*, the objectives and agenda of UNISPACE III, various means of achieving the objectives of the conference and their financial implications.

52. On the basis of the recommendation of the Subcommittee, the Committee at its 1996 session agreed that a special session of the Committee (UNISPACE III), open to all States Members of the United Nations, should be convened at the United Nations Office at Vienna in 1999 or 2000. The Committee agreed with the Subcommittee on the set of objectives and also agreed that every effort should be made to limit the cost of UNISPACE III in order to keep it within the existing resources for the Committee and its secretariat by reducing or curtailing the duration of the sessions of the Committee and its subsidiary bodies during the year of the conference. Those agreements of the Committee were endorsed by the General Assembly at its fifty-first session. Based on the recommendations of the Committee, the Assembly, in its resolution 51/123 of 13 December 1996, also requested the Committee and the Scientific and Technical Subcommittee to act as Preparatory Committee and Advisory Committee for UNISPACE III, respectively, and the Office for Outer Space Affairs to act as the executive secretariat.

53. Following intense work within the Working Group of the Whole, which was requested by the Advisory Committee to assist its work at its 1997 session, consensus agreement was finally reached on the agenda of UNISPACE III. At that session, the Advisory Committee made a number of additional recommendations concerning the date, participants, additional components and financial aspects of UNISPACE III. At its

1997 session, while endorsing those recommendations, the Preparatory Committee agreed upon the procedure to prepare the draft report of UNISPACE III.

54. The General Assembly, in its resolution 52/56 of 10 December 1997, agreed that the Third United Nations Conference on the Exploration and Peaceful Uses of Outer Space (UNISPACE III) should be convened at the United Nations Office at Vienna from 19 to 30 July 1999 as a special session of the Committee on the Peaceful Uses of Outer Space, open to all States Members of the United Nations.

B. Purpose and objectives

55. The purpose of the Third United Nations Conference on the Exploration and Peaceful Uses of Outer Space is to review and highlight the significant advances of space science and technology that have taken place since 1982 with a view to promoting their greater use in particular by developing countries, in all areas of economic, social and cultural development. At the same time, the Conference would provide a unique forum in which States Members of the United Nations, organizations of the United Nations system, intergovernmental and non-governmental organizations with space activities and the space-related industries could be involved in developing a blueprint for international cooperation in space-related activities for the beginning of the next century. Such a gathering would bring together, for the first time, all interested parties and relevant actors.

56. The UNISPACE III Conference, whose theme will be "Space benefits for humanity in the twenty-first century", will aim at achieving the following primary objectives: promoting effective means of using space technology to assist in the solution of problems of regional or global significance; and strengthening the capabilities of Member States, in particular developing countries, to use the applications of space research for economic, social and cultural development. The other objectives of UNISPACE III are as follows:

(a) To provide developing countries with opportunities to define their needs for space applications for development purposes;

(b) To consider ways of expediting the use of space applications by Member States to promote sustainable development through the involvement of a larger number of developing countries in international research programmes such as the International Geosphere-Biosphere Programme and the World Climate Research Programme;

(c) To address the various issues related to education, training and technical assistance in space science and technology and their applications aimed at the development of indigenous capabilities in all States;

(d) To provide a valuable forum for a critical evaluation of space activities and to increase awareness among the general public regarding the benefits of space technology;

(e) To strengthen international cooperation in the development and use of space technology and applications.

IV. HARNESSING THE POTENTIAL OF SPACE AT THE START OF THE NEW MILLENNIUM

A. Protecting the environment

1. Scientific knowledge of Earth and its environment

(a) Status: environmental and Earth sciences

57. In the twenty-first century, the planet Earth will face the potential hazard of rapid environmental changes, including warming of the climate, rising sea level, deforestation, desertification and land degradation, depletion of the ozone layer, acid rain and a reduction in biodiversity. Such changes could have a profound impact on all countries, yet many important scientific questions remain unanswered.

58. The Sun is a variable star that provides all energy for living things on Earth. That energy is also the principal driving force of the atmosphere and ocean circulation systems and the climate of the Earth. The energy from the Sun comes in the form of radiation, for instance, the visible illumination that is necessary for plant photosynthesis, and of energetic particle streams. To understand the influence of the Sun on the Earth's environment, it is necessary to trace the flow of radiation and charged particles from the Sun and to determine its effects on the coupled magnetosphere-ionosphere-atmosphere of Earth, especially the stratospheric ozone layer.

59. The ultraviolet irradiance of the Sun is the dominant energy source for the Earth's upper atmosphere. Small changes in the atmosphere (for example, in total ozone) can produce significant differences in the solar radiation reaching the Earth's surface. Increasing ultraviolet radiation is known to cause increases in the occurrence of skin cancer and can affect microbiological systems by damaging or altering their genetic structure.

60. In order to determine solar influences on global change on Earth, it is critical to monitor from vantage points far from Earth the total and spectral distribution of solar irradiance, the structures and composition of the middle and upper atmosphere over many solar cycles, solar wind, the energetic particle input into the Earth's magnetosphere and coronal mass ejections.

61. The Earth's magnetosphere and atmosphere are closely linked to the atmosphere and heliosphere of the Sun. Variations in the solar atmosphere, including flares and ejection of charged particles from its corona, and their interaction with the Earth's magnetosphere and upper atmosphere are governed by physical processes that are known only in part.

62. The variable interaction of the Sun with the Earth's magnetosphere, ionosphere and upper atmosphere can create potentially damaging environments for space assets that provide weather forecasts, telephone and other forms of communication, television, navigation and other important services. An example of a casualty of space weather is the recent temporary failure of Anik E2, a communications satellite, after being bombarded by high-energy electrons triggered by the Sun.

63. The possibility of unprecedented global climate change exacerbated by human activity is a subject of considerable international concern. That concern has been expressed through the United Nations Framework Convention on Climate Change. For several years the Intergovernmental Panel on Climate Change has been issuing periodic scientific assessments of global climate change and its possible impact. The Intergovernmental Panel estimates that global surface air temperatures will increase significantly over the next 100 years. The likely consequences of such warming include changing patterns of precipitation and temperature, a rise in the

sea level and altered global distribution of freshwater. The impact on human health, the vitality of forests and the productivity of agriculture is likely to be significant.

64. Global climate is a consequence of complex interactions between the solar energy input to Earth, the atmosphere (and atmospheric composition), the oceans, the hydrological cycle, the land surface and vegetation, the cryosphere (snow and ice fields, ice sheets and glaciers) and the geosphere (including continental topography and tectonic changes, volcanic eruptions and the rotation of Earth).

65. The past history of Earth demonstrates that the climate has changed many times through very cold and warm periods as a result of orbital changes of Earth, solar fluctuations, volcanic eruptions or other natural factors. The current concern is that human activity could be an equally strong factor in causing climate change, at a rate much more rapid than that experienced before. Thus, the adaptation time for humans and plant and animal life to a changed environment might be too short.

66. Recent climate history shows that there has been a global warming of about 0.5° C over the last 100 years. Corresponding changes have been observed in the rise of the sea level in coastal areas. The warming is thought to result from increasing concentrations of greenhouse gases such as carbon dioxide, injected into the atmosphere during the burning of fossil fuels, methane, emitted by an expanding agriculture and a growing number of livestock, oxides of nitrogen, caused by burning of fossil fuel (for example, by airplanes and automobiles) and possibly fertilizers, as well as chlorofluorocarbons, used in air-conditioning. Chlorofluorocarbons also destroy the ozone layer, thereby allowing increased ultraviolet-B radiation to penetrate the atmosphere.

67. Ozone is the only greenhouse gas that strongly absorbs solar radiation in the ultraviolet part of the electromagnetic spectrum in the stratosphere. Stratospheric ozone protects the Earth's surface from harmful solar ultraviolet-B radiation and plays an important role in controlling the temperature structure of the stratosphere. Thus the hypothesis is that a reduction in stratospheric ozone could also modify surface temperature.

68. Stratospheric ozone depletion is now evident all around the world, except over tropical latitudes. The Antarctic ozone hole is the most conspicuous manifestation of ozone depletion, which has recently accelerated in the Arctic winter and spring. There is compelling evidence that ozone depletion can be ascribed to the increased atmospheric burden of human-made chlorine and bromine compounds. International regulations have been established to phase out the production of such compounds, and they have begun to diminish. However, the decrease will be slow and it will be necessary to observe stratospheric ozone to determine whether the recovery from depletion will take place as expected.

69. Technological advances over the past several decades have contributed substantially to improvements in transport systems, agricultural food production and distributions systems, water availability and power generation and distribution, in addition to recent enhancements in computerization to meet the needs of the information age. In retrospect, such progress has been achieved at considerable cost to the environment. The dilemma is therefore how to maintain sustainable economic, social and technological development without further undermining the integrity of the environment.

70. In addition to human activities, there are natural causes that also have adverse effects on the global environment. Such causes include forest fires, volcanic eruptions, earthquakes, tsunamis, hurricanes, cyclones, typhoons, floods, drought and phenomena such as El Niño.

71. All those human activities and phenomena can now be observed and their effects on the global environment detected from outer space with the use of satellites. The preservation of the near Earth space

environment has also become important to protect those useful tools to diagnose the state of the Earth and is critical to the future exploration and use of outer space. A growing number of space activities are increasingly at risk because of the production of man-made space debris. Currently, more than 8,000 catalogued objects more than 10 centimetres in diameter, and an even larger number of smaller objects, are orbiting the Earth, yet only about 500 can be considered operational spacecraft. Collision with any of them could lead to damage or even functional loss of operational spacecraft. One such collision of a catalogued object with a satellite was recently documented.

72. Methods for monitoring the space debris environment involve ground-based optical and radar observations, space-based detectors, as well as investigations of microscopic damage of the surface of objects retrieved after long-term exposure to the space environment. Assessing the present and future risk to operational space objects by the space debris environment has to rely on the use of models because observations do not cover the whole range of particle sizes and spatial distribution. Mitigation techniques include protection against the impact of space debris or collision avoidance and measures to avoid the creation of space debris, since economically feasible methods for clearing debris in space currently do not exist.

73. The Scientific and Technical Subcommittee of the Committee on the Peaceful Uses of Outer Space agreed that international cooperation was needed to expand the scientific and technical basis for appropriate and affordable strategies to minimize the potential impact of space debris on future space activities. In 1995, the Subcommittee adopted a multi-year work plan to focus on debris measurement techniques, mathematical modelling and characterization of the debris environment and measures to mitigate the risk of space debris. The multi-year work plan was carried out in collaboration with the Inter-Agency Space Debris Coordination Committee and the International Academy of Astronautics from 1996 to 1998 and the Subcommittee finalized its technical report on space debris in February 1999.

74. Space objects, including space debris, are also contributing increasingly to the light pollution of the space environment, adversely affecting ground-based astronomical observations. The passage of an artificial space object across the field of view of an astronomical telescope can degrade both photographic and photometric studies. The phenomenon is not new, but with the launch of multi-satellite systems that can create frequent short-duration flashes of intense light, the light pollution is increasing. In addition, there have been proposals for the launch of large solar reflectors for illumination and transmission of energy and even projects for advertisements and celebration purposes using large space objects that reflect a significant amount of light. The International Astronomical Union (IAU), the Committee on Space Research and the Scientific and Technical Subcommittee of the Committee on the Peaceful Uses of Outer Space are strongly opposed to such activities, which would change the outer space environment and hamper astronomical observations. Attention should be given to preserving or restoring astronomical observation conditions to a state as close to natural as possible by any practicable means.

(b) Issues and objectives

75. The observational requirements arising from the need to understand more fully the Earth's system and to initiate corrective steps based on that increased understanding are wide-ranging and involve many different measuring techniques and associated data-processing systems. Satellites are capable of providing the synoptic, wide-area view required to put *in situ* measurements in the global context needed for the observation of many environmental and climatic phenomena.

76. To improve understanding of the influence of the Sun on the Earth's environment, it will be necessary to pursue the following issues and objectives: (a) continued observations and long-term monitoring of solar spectral irradiation; (b) modelling the dynamics of the Sun and its fluctuations; (c) assessing the interaction

between solar fluctuations and the Earth's climate; and (d) quantifying, through observations and models, solar influences on both short-term (seasonal to inter-annual timescales) and long-term (10-30 year) climate change.

77. To improve understanding of the relationship between charged particle fluxes from the Sun and the Earth's environment, it will be necessary to pursue the following issues and objectives: (a) investigating solar system plasmas and the electric current systems and magnetic plasmas associated with them; (b) improving the observation and understanding of the physical processes governing the Earth's thermosphere, magnetosphere, ionosphere and upper atmosphere; (c) developing a detailed, theoretically grounded understanding of the physical processes that constitute the Earth-Sun connection and improved forecasting of space weather; (d) improving the observations and understanding of solar variability; and (e) characterizing the dynamics, properties and structure of the solar wind as it interacts with the local interstellar medium to form the heliosphere.

78. To improve understanding of global climate change, it will be necessary to pursue the following issues and objectives: (a) characterizing and documenting long-term climate variability and trends through systematic global observations of the atmosphere, oceans, land surface/biosphere and cryosphere of the climate system and the external forces that affect it; (b) understanding the nature of key parameters that give rise to change in the climate system and identifying the causal factors of observed climate variations and feedback processes that govern the response of the climate system; and (c) assessing the predictable aspects of long-term climate variability and changes, including their regional impact, through the combined application of observation and global models.

79. To improve understanding of change in the ozone layer and its effects on the environment and human health, it will be necessary to pursue the following issues and objectives: (a) characterizing the global distribution of ozone, chemically active trace constituents and related meteorological parameters; (b) understanding the processes responsible for the chemical transformation of trace constituents and the role of aerosols in affecting atmospheric chemistry; and (c) quantitatively modelling the trace constituent composition of the troposphere-stratosphere system through the combined application of observations and global models.

80. To improve understanding of anthropogenic impacts on the environment and human health, it will be necessary to pursue the following issues and objectives: (a) monitoring atmospheric/tropospheric pollutants, aerosols and other chemical species; (b) observing and monitoring the discharge of rivers into inland lakes and coastal zones; (c) understanding the interaction between the by-products of technology and the environment and modelling their impact; and (d) observing and monitoring natural effects on the global environment.

81. A number of international activities are being carried out to utilize satellite data to assess and monitor conditions on Earth, such as DIVERSITAS, the International Geosphere-Biosphere Programme, the International Human Dimensions Programme on Global Environmental Change, the World Climate Research Programme and global observing systems, including the Global Climate Observing System (GCOS), the Global Ocean Observing System (GOOS) and the Global Terrestrial Observing System (GTOS). The Committee on Earth Observation Satellites (CEOS), consisting of a number of national space agencies and space-related international organizations, has also initiated discussions with the three global observing systems and their sponsoring organizations, including the International Group of Funding Agencies for Global Change Research, to develop an Integrated Global Observing Strategy (IGOS) aimed at providing an overarching strategy for Earth observations, allowing organizations involved in the collection of data to extend their contribution and assisting user groups, in particular those from developing countries.

2. *Environment and natural resources and remote sensing*

(a) Status: environment and natural resources and applications of remote sensing

82. Human activity has altered the condition of Earth by reconfiguring the landscape, by changing the composition of the global atmosphere and by putting stress on the biosphere. Although there are many ongoing efforts to redress the situation, there continue to be strong indications that natural change is being accelerated and distorted by human intervention. In its quest for an improved quality of life, humanity has become a force for change on the planet, building upon, reshaping and modifying nature in unintended and often unpredictable ways.

83. Development decisions require accurate and comprehensive information, for instance on soils and land use, water resources and agricultural and other resources. Such information would make possible an evaluation of their potential uses and interdependencies and their likely responses to different types and levels of use. Crop or stock suitability, irrigation methods and run-off potential are typical parameters that need to be assessed for a given series of locations with particular climates, soils, ecosystems and alternative land uses.

84. Present-day applications of satellite data are widespread and cover research and operational and commercial activities. Those activities are of interest both in the global context and in the regional, national and local contexts, where Earth observation data are successfully applied in support of a range of different application areas. Several applications involve weather-related phenomena, disasters or the management of Earth's resources. The relevance of remote sensing in those areas is described below.

Applications in weather forecasting

85. The weather at any given location is a result of complex interactions between local, regional and global aspects of atmospheric circulation and dynamics, which in turn are affected by the interactions of the atmosphere with the oceans, the land surface and vegetation and the cryosphere.

86. Since many weather phenomena are directly related to the economy and well-being of society, weather forecasting has been a crucial requirement of societies around the world for centuries. Weather forecasts are currently generated by global models, which are in turn used to create high-resolution regional models in order to forecast more specific local details of weather systems, such as temperature, wind and precipitation.

87. Major emphasis is being placed on the development of seasonal to inter-annual prediction capability because of the lead times required for the management of natural and industrial resources such as agriculture, water supply and energy production and distribution. Accurate forecasting of weather systems is of particular importance in preventing or reducing damage due to natural disasters. All the prediction models require global observational data for their daily initialization.

88. *In situ* and space-based observations are made globally approximately every three hours as part of the World Meteorological Organization (WMO)'s World Weather Watch observations and are transmitted to processing centres that establish weather forecasts for periods of 24 hours to about a week. For longer periods, extended-range forecasts are also made. For predictions on a seasonal to inter-annual timescale to capture phenomena such as El Niño, atmosphere-ocean coupled models need to be used. They require substantially more observations of the Earth's system for their initialization and time integration.

89. Future satellite missions will make improved and better calibrated observations of the above-mentioned and other parameters. Examples of satellite missions are INSAT-2E (India), ADEOS-II (Japan), Resurs 21 and Nika-Kubany (Russian Federation), EOS-AM/EOS-PM and CHEM (United States of America),

NPOESS/METOP (United States/Europe), SeaWifS (United States), ENVISAT (European Space Agency (ESA)) and Skynet Cosmo (Italy). The instruments will also collect data on the concentration and distribution of greenhouse gases and on ozone chemistry, which are needed in climate change models.

90. Ongoing satellite missions make or help derive key global observations of atmospheric structure and dynamics, sea-surface temperature, surface parameters, precipitation, land-surface characteristics and selected atmospheric chemical species via geostationary and polar-orbiting platforms. Examples of those satellites systems are GMS, GOES, GOMS, INSAT and METEOSAT and the METEOR and NOAA-AVHRR series of meteorological satellites, the Earth observation series of satellites, including Fengyun (China) , IRS (India), LANDSAT (United States), SPOT (France) and Okean (Russian Federation), as well as the TOPEX/Poseidon (United States/France) ocean circulation mission. Recently, ERS-1 and -2 of ESA, SIR-L/X-SAR of Germany/Italy, JERS of Japan and RADARSAT of Canada have made it possible to map the Earth's surface through clouds or at night in the locality concerned, while providing new information on geological features, topography, atmospheric structure, sea ice, deforestation, bathymetry, coastal zones, oceanography and agricultural assessments, among other things. Areas in which radar satellites are particularly effective include determination of global wind and wave fields at high spatial and temporal resolution over ocean areas, as well as global ocean dynamics and climatic instabilities. Many of these missions are part of the World Weather Watch space-based subsystem.

Applications in disaster management

91. Every year there are hundreds of natural disasters that afflict populations in many countries on all continents. In 1996 alone, there were 180 reported natural disasters, of which 50 were major, requiring international assistance. In the past 10 years, there have been 64 very large disasters with extremely serious consequences, such as the floods that occurred in China in 1991 and 1996, hurricanes Andrew, Luís and Marilyn, and the European-Mediterranean floods of 1997. The economic losses in the past 10 years are estimated at $400 billion.

92. Through the implementation of effective public policies and thanks to scientific and technological developments, there has been a decrease in the number of fatalities worldwide. Possibly the most notable use of such technology is provided by the early detection and warning given by meteorological satellites in the case of typhoons and hurricanes, for example, the Tropical Cyclone Programme of WMO.

93. While developed countries suffer greater economic damage in absolute terms, the impact on developing countries is more severe in relative terms. The gross national product lost as a result of natural disasters is estimated to be 20 times greater in developing countries than in developed countries.

94. Disaster management includes the following elements: (a) disaster mitigation, which involves hazard mapping, risk assessment and presentation of information for the elaboration of land use legislation; (b) disaster preparedness, which involves forecasts and early warning; (c) disaster relief, which includes action taken to mitigate the effects of the disaster after it occurs, such as assessment of the damage and delivery of health care, food and other supplies; and (d) disaster rehabilitation, which involves long-term measures that begin during the relief phase.

95. Space technologies can play important roles in early warning and management of the effects of disasters. However, an operational disaster management support service that uses the capabilities of space systems can only be achieved through the joint use of satellite communications and remote sensing images, including services and other products of space systems, with other non-space sources providing ground information.

96. As natural disasters often destroy or severely disrupt terrestrial telecommunication networks, satellites have found a vital role to play in supporting or making possible disaster management activities, including the emergency gathering and dissemination of news and the provision of back-up communications for the continuation of government and business activities.

97. Data from meteorological and Earth observation satellites provide essential information for hazard mapping, risk assessment, early warning and disaster relief and rehabilitation. Such data are particularly useful when combined with ground-obtained data and information and integrated into geographic information systems (GIS) for analysis and modelling of complex scenarios.

98. Navigation and positioning satellite systems are another promising tool for disaster prediction, warning and relief activities. With ground positioning receivers and through repeated observations, it is possible to determine relative motions of parts of Earth to within a few millimetres. That could make it possible to assess and map earthquake risk and predict volcanic eruptions and landslides. The use of optical or radar images for stereoscopic viewing are also useful for that purpose.

99. A sinking ship, a fallen airplane or even a person lost in the wilderness represents a different type of disaster. They are distress situations in which receiving immediate assistance can mean the difference between life and death. The International Search and Rescue Satellite System (COSPAS-SARSAT) is an international search and rescue system based on receivers on board meteorological satellites that relay signals from transmitters activated in distress situations to a network of ground stations. The signals are processed to determine the geographical location of the transmitter. Since 1982, COSPAS-SARSAT has saved the lives of several thousand people worldwide. Canada, France, the Russian Federation and the United States of America provide the space segment for the system, which is supported on the ground by many countries.

100. Recognizing the need for a global effort to reduce the impact of natural disasters, the international community proclaimed the International Decade for Natural Disaster Reduction, beginning in 1990 (General Assembly resolution 44/236 of 22 December 1989). As the Decade reaches its conclusion, there is evidence that enormous synergy has been established in the disaster management community throughout the world. The Office for Outer Space Affairs, in cooperation with ESA and the secretariat of the International Decade, has organized regional workshops (held in China in 1991, Zimbabwe, 1995, and Chile, 1996) designed to raise awareness, among policy makers and managers of civil defence and protection bodies, of the usefulness of space technology in support of disaster management. The workshops made recommendations on the need to incorporate the use of space technologies into disaster management planning and operational activities.

Applications in management of resources

101. Satellite remote sensing offers several advantages over alternative means of data collection, such as airborne and ground surveys. The advantages relate to the lower cost of data acquisition, the speed and relative ease with which satellite images can be obtained and the high frequency of coverage, strengthened by the recent advent of high-resolution remote sensing satellites. While remote sensing makes a significant contribution to fulfilling information needs, its role is complementary to other means of spatial data acquisition.

102. The archived remote sensing data represent a valuable source of consistent information that permits retrospective (time-series) studies, such as those determining the origin of marine pollution or the rate of depletion of a specific resource. Archives of satellite images can now be readily consulted from remote locations, as a result of the growth of information systems and the Internet.

103. GIS is used not only as a database for the storage and retrieval of spatial information, but also as an interactive management tool for analysing alternative strategies for resource allocation. The digital format of

images and the synoptic coverage of remote sensing satellites facilitate processing of the images into products meeting a variety of needs. Such a characteristic allows the elaboration of value-added GIS-ready products meeting the specific needs of various groups of users from the same set of source images, thereby making possible economies of scale.

104. Maps are needed for a wide range of planning and development activities. However, in developing regions and even in some developed countries, such maps are scarce or outdated, in part because of the high cost of preparing them using traditional approaches. The availability of satellite remote sensing images is modifying the way in which maps are prepared and subsequently used. The images themselves are ortho-rectified, annotated and used as maps. Such maps provide more information content and are more readily understood by a wide variety of end-users.

105. The wide perspective of satellite images has allowed geologists to map subtle regional geological features (such as faults, lineaments and geomorphological or lithological contacts) that would not otherwise be easily observed from the ground. The mapping of such features facilitates exploration for minerals as well as for groundwater, both of which are key resources for development.

106. In agriculture, remote sensing is used to supplement conventional sources of information in establishing agricultural statistics and determining areas of arable land. Optical imagery with low to high spatial resolution from multiple dates as well as radar imagery is used in the identification of crops. Radar imagery is particularly useful in areas such as the humid tropics and northern Europe, where frequent cloud cover may obscure the land surface.

107. Monitoring of crops on individual farms using high-resolution imagery helps to identify areas under stress because of lack of water, in need of fertilizer or affected by disease long before the plants begin to show visible evidence of such a state. That facilitates optimal distribution of water, thereby making savings possible as well as improving crop yields. It also helps to avoid excessive application of fertilizer, with its potentially harmful effects on the environment.

108. Multi-date satellite imagery of crops is used in conjunction with other information, for example, meteorological and soil data, to develop models for forecasting yield several weeks before harvesting. That application can be of considerable value to developing countries. Forecasts are useful in making timely arrangements for the storage, import, export and efficient local distribution of agricultural produce. Low production forecasts (for example, as a result of drought) would allow time for remedial measures to be implemented. Such is the basis for programmes such as the Famine Early Warning System of the Food and Agricultural Organization of the United Nations (FAO), which benefits a number of countries in Africa.

109. The onset of drought in a given year can be predicted by comparative analysis of the trends in satellite-derived vegetation indices for that year relative to the trends in a normal year. Early warning has allowed authorities in some developing countries to mitigate the effects of drought through redistribution of food supplies for humans and fodder for livestock. The FAO early warning system for Africa, the African Real-Time Environmental Monitoring using Imaging Satellites (ARTEMIS), is based on that capability.

110. Space applications have much potential for use in other areas related to agriculture and the environment. Remote sensing techniques are very important for real-time detection of forest fires, quantification of burnt areas and monitoring of the regeneration of affected areas. Such techniques are also valuable in identifying the deforestation process and to measure the rate at which it occurs, in particular in large forest areas. Likewise, the use of remote sensing techniques is very useful in determining processes that cause desertification and the related loss of agricultural areas.

111. Coastal zone management benefits from satellite information on factors such as water quality, suspended sediment and sea surface temperature, which can be used to monitor river outflow and track oceanic features. Oceanographic applications include provision of accurate information on likely fishing grounds (based on sea surface temperature), monitoring of coastal dynamics, ocean wave forecasting for ship routing, measurement of the topography of the sea floor for off-shore exploration and monitoring of oil slick pollution. Radar satellites also make possible improved sea ice and iceberg monitoring for offshore activities and ship routing in polar regions.

112. Rising worldwide demand for potable water to supply the increasing world population has heightened the need for assessment and management of water resources. Remote sensing satellites provide data on several key hydrological variables (for example, rainfall, soil moisture, evaporation and snowfall) using a scale that is appropriate for assessment. A satellite-based approach to assessment of water resources is especially important in regions of the world where adequate hydroclimatological networks do not exist.

113. Many of the components of the hydrological cycle, such as drainage features and channel networks, quantities and quality of water flows, fractures, lineaments and man-made features, can be mapped or determined quantitatively from images obtained from satellites far better and more quickly than through ground-based methods. Remote sensing data are used to measure snow extent and snow water equivalent, as well as to estimate rainfall. The extent of floods can be mapped directly using radar and optical imagery, while the volume of run-off within watersheds can be estimated indirectly. Other parameters of importance in hydrological investigations, such as soil moisture, evapo-transpiration, vegetation, land use and land cover, can also be estimated or mapped using satellite remote sensing techniques.

Applications in disease control and health services

114. Data from remote sensing satellites, in combination with other information, have been used successfully to monitor the environmental preconditions for the emergence and outbreak of vector-borne diseases. The next generation of research and operational Earth observation satellites, along with studies on empirical relationships between vector-borne diseases and weather and climate variability and climate change, will provide increasingly accurate information for early warnings of impending global health issues. Early warnings are a prerequisite to developing mitigation measures aimed at reducing the effects of vector-borne diseases.

115. Member States, in coordination with international organizations such as the World Health Organization (WHO) and the World Bank, are conducting activities to establish relationships between environmental parameters that can be sensed by satellites, such as water, temperature and vegetation cover, the occurrence of disease vectors (e.g. mosquitoes, ticks and flies), disease reservoirs (e.g. deer and rodents) and patterns of human settlements, migration and land use. Based on those relationships, predictive models can be developed to aid public health efforts to control specific diseases. An early warning surveillance system for Rift Valley fever has been successfully developed for east Africa by combining remote sensing and epidemiological data. Through an international cooperative effort, involving a space agency, international organizations and non-governmental organizations, investigators from Brazil, Mexico, Peru and Venezuela are being trained in health applications of space-related technologies.

116. Telemedicine applications are increasingly used in emergency and disaster situations involving health hazards. WHO uses mobile satellite communications for epidemic control, most notably in Africa, as part of its rapid epidemic response kit to combat diseases such as river blindness or fast-spreading health hazards such as ebola. Slow-scan video communications for medical consultations are also possible via moderate-speed satellite data links and were used, for example, after a recent major earthquake in Armenia.

(b) Issues and objectives

117. Among the major information needs for many developing countries are those required to support decision-making in important sectors such as natural resources (including agriculture, forestry, minerals, water and fisheries), the environment, human resources (including education and health services) and prevention and mitigation of natural disasters. Successful remote sensing applications in those sectors have resulted in a number of direct and indirect benefits to society.

118. An issue relating to the use of Earth observation data concerns the wide variety of satellites offering data with diverse formats and calibration details, with each satellite requiring specific technical upgrades for data reception. The associated access fees and the hardware and software add-ons for data product generation require financial commitments. Standardization of reception hardware and data-processing software tools is an area where cooperative activities can play a major role. There is also a need to address the increasing number of ground receiving stations in a cooperative framework to ensure the availability of all data to all countries with minimal investment. Such availability is linked to prices of data and policies for sharing data and information.

119. Another issue faced by users of Earth observation data, in particular those in developing countries, is the quantity and location of the data. An abundance of data does not necessarily mean that the data are available in a timely manner in all situations, since locating them may be a problem. Even if data are available, their usefulness depends on proper interpretation and analysis. Given the plethora of data available, without sufficient experience it is often difficult to select the right data to maximize the benefit to be derived from the data sets. Other related issues are the storage and archiving of data, linked to a disposal policy over time, the obsolescence of hardware and software and data-pricing policies, all of which create constraints to a broader use of the data.

120. The cost of remote sensing data is another issue of concern, in particular to some developing countries. For a number of years there has been increasing marketing of the products derived from space-borne remote sensing, with marked interest being shown by the private sector. This has reduced the need for governmental subsidies. The cost of acquiring satellite data is justified if their use affords measurable advantages in connection with the project in question, such as, for example, a time saving, a cost reduction or the fact that such detailed information would not be obtainable by any other means. Despite a downward trend in the cost of remote sensing data, it is still considered too high by some developing countries and efforts should be made to promote further the availability of data for such countries at an affordable price.

121. Another issue involves the final use by policy and decision makers as well as by programme managers of the information derived from satellite data. Earth observation satellites provide essential data on conditions on Earth, allowing experts in the remote sensing field to assess the regional and global environment. While such data can provide evidence of the seriousness of environmental and health problems caused, for example, by poor management of land and water resources, vector-borne diseases and pollution, such information from satellites needs to be translated into specific actions in order to solve the persisting problems. Data from Earth observation satellites can give early warning of natural disasters, but specific actions should then be taken to prevent and mitigate the effects of such disasters.

122. The continuity of satellite data is essential to increasing the credibility and value of the information provided by satellites. Policy and decision makers as well as managers of programmes concerned with environmental and developmental problems need to know that they can depend, on an operational basis, on the information derived from the data. The successful use of data in terms of quality of the final product and of a cost-benefit analysis is an important milestone that would eventually lead to their routine use in planning and management activities. Further efforts should be made to enhance and ensure access, on a continuous basis, to various sources of satellite data and to demonstrate their usefulness.

123. There is also a need to explore ways and means further to coordinate ongoing international efforts to make scientific observations of Earth. A number of international initiatives have already been taken to examine various aspects of the global environment. To maximize the use of resources allocated to the monitoring of the Earth's environment, it may be useful to review information needs that have not been met by any ongoing monitoring initiative and to consider integrating some of the activities implemented within the framework of various initiatives. To do so, it is crucial to ensure the compatibility of the data exchanged.

124. To improve understanding of weather phenomena and their effects on the environment and human activities, it will be necessary to pursue the following objectives:

(a) Development of remotely sensed observations and their use together with *in situ* observations to monitor, describe and understand the dynamics of the atmosphere, including climate system variability on all timescales ranging from a few hours to months, seasons and inter-annual periods of fluctuation;

(b) Ensuring that the observations thus collected are in a form conducive to integrated data assimilation by forecast and prediction models; a primary aim is to improve the capability to predict socio-economically important weather and climatic events;

(c) Improvement of the coverage (in surface area and in terms of additional parameters and variables that are needed) for the calibration and validation of current and planned satellite and remote sensing observations;

(d) Improvement of remote sensing data retrieval algorithms so that the geophysical parameters derived are more representative of direct measurements;

(e) Improvement of the input of globally observed satellite measurements directly into global models.

125. The potential contribution of space techniques to disaster management is theoretically well accepted. However, civil protection authorities and other concerned bodies do not yet make extensive use of the techniques. There is thus a need to initiate activities that will assist civil protection authorities in identifying appropriate space technologies to support disaster management and to enable them to acquire practical experience in the use of space technologies.

(c) Specific action programmes

126. The establishment of an integrated global observing strategy such as that being discussed by the sponsors of the global observing systems (GOOS, GCOS, GTOS) and by CEOS should be further pursued and supported. The establishment of a strategy that combines current and planned space capabilities with those on the ground should involve international bodies and national agencies and organizations and needs to be user-driven. A systematic assessment of user needs and the ability of the satellite instruments to meet those needs is required. Commitments would be needed from space agencies to meet the resulting requirements and also from the users to maximize the use of satellite-derived inputs in their modelling and decision-making processes.

127. As one of the steps towards an integrated global strategy, the United Nations should support initiatives such as those of CEOS and the German Aerospace Research Establishment (DLR) to develop a CEOS information locator system on the Internet, which users in developing countries could use to find information about Earth observation data. The system should provide for the easy and inexpensive location, collection and sharing of data, as well as the interoperability and management of the users' own data. The possibility of converting such a network information database into a structured international framework for cooperation, combining satellite data with ground-based or other data, should be explored.

128. The Office for Outer Space Affairs, in cooperation with relevant departments of the United Nations system, the specialized agencies, space agencies and value-added companies, should initiate a programme to promote the use of Earth observation data for planning and managing programmes and projects by user institutions in developing countries. The programme could identify ongoing national and regional projects in the areas of natural resource management, environmental monitoring and sustainable development that could benefit from the use of optical, infra-red or radar data and improve their effectiveness.

129. The goal would be an improved policy, decision and management process in participating institutions on the basis of timely and accurate information derived from satellite data. The programme would strengthen the capability of institutions to use satellite-obtained data in support of projects and programmes in areas of economic and social improvement. The selection criteria for participating projects would include a funding guarantee for all non-remote-sensing aspects and the ability, either by themselves or through a cooperative arrangement with a local institution, to utilize satellite data. Participants would report to their decision makers the results of their use of satellite data, including a cost-benefit analysis.

130. A needs assessment should be conducted by the Office for Outer Space Affairs and its partners to identify the type and coverage of satellite images required by each participating project. Those images and the software packages necessary to process them would be acquired for each project. A short training course to acquire hands-on experience with the actual images and software that they would receive would be organized for those who work on the projects.

131. The training courses to be organized, one per developing region per year, could be included in place of one of the yearly training activities of the United Nations Programme on Space Applications. The capabilities of the regional centres for space science and technology education could also be used for that purpose. Additional costs due to the specialized materials and possibly travel expenses for expert lecturers needed by the courses would be minimal.

132. The costs involved for the United Nations would be primarily in terms of staff work-months that could be covered within existing resources of the Office by a rearrangement of priorities in work assignments with modest additional costs. The time-frame for the activity would be three years. In consultation with the participating institutions, the Office would report to the Scientific and Technical Subcommittee on the progress made.

133. The international space community, including the United Nations system, space agencies and international organizations such as CEOS, non-governmental organizations and space-related industries should initiate a comprehensive programme to promote the use of satellite communications and Earth observation data for disaster management by civil protection authorities, in particular in developing countries. The goal would be to encourage civil protection institutions to utilize space technology in all relevant aspects of their work and to promote their participation, in an incremental manner, in international initiatives such as a possible global disaster monitoring system. The programme should build on the experience and accomplishments of completed and ongoing activities, such as those organized by the United Nations in cooperation with ESA (see para. 100). The programme should also build on work done at the regional level, in particular through the preparatory conferences for UNISPACE III, and should be in line with relevant recommendations of UNISPACE III.

134. The programme should include activities such as those indicated below, which might initially be implemented through pilot projects:

(a) Identification of the data products corresponding to the requirements of the user (civil protection authority), concerning, for instance, information content, delivery time, means of dissemination and support, as well as formats;

(b) Establishment of a user request procedure;

(c) Consolidation and validation of the answering procedure by data providers;

(d) Validation of the procurement, interpretation and distribution of data and products through emergency simulation exercises;

(e) Establishment and validation of products and services for prevention, crisis and post-crisis activities in relation to user requests;

(f) Validation of the overall pilot project activities in close cooperation with the users.

135. As part of the programme, the Office for Outer Space Affairs, in collaboration with the secretariat of the International Decade for Natural Disaster Reduction and other interested institutions, would organize working meetings, on a regional basis, of civil defence and protection managers with providers of space technology and services to define areas where common efforts are advisable (for example, regional databases) and others where actions by individual institutions are necessary. The meetings would also serve to identify specific needs of civil protection institutions that could be met through the use of space technologies. On the basis of those specific needs, the programme would provide technical assistance to acquire appropriate space technology and know-how, leading in some cases to pilot projects to demonstrate and test the technology. The working meetings could be organized within the framework of the United Nations Programme on Space Applications and that of the regional centres for space science and technology education.

136. An additional consideration would be that the International Decade for Natural Disaster Reduction will culminate in 2000 with a meeting, which, among other things, will stimulate new actions to achieve the goals of the Decade. The Office for Outer Space Affairs would ensure that any disaster-related recommendations made by UNISPACE III were considered and taken into account in the recommendations adopted at the final event of the Decade and that some specific actions, such as the initiation of pilot projects, were included.

137. Assessments are required continuously to guide rational and effective decision-making for environmental, health, social and economic policy formulation, implementation and evaluation at the local, national, regional and global levels. To improve the global capability for keeping the environment under continuous review, urgent action is required in the following fields:

(a) Investment in new and better data collection, in the harmonization of national data sets and in the acquisition of global data sets;

(b) Enhanced capabilities for integrated assessment and forecasting and analysis of the environmental impact of alternative policy options;

(c) Better translation of scientific results into a format readily usable by policy makers and the general public;

(d) Development of training courses and workshops for scientists from developing countries on the use of satellite data for monitoring the environment and modelling change.

138. To reach its full potential for operational applications in terrestrial, environmental and disaster monitoring, satellite remote sensing must ensure the high revisiting rate needed for applications in support of sustainable development. That could be achieved through coordination of orbital parameters between satellite operators in order to ensure a high revisit capability. Such coordination is encouraged to the extent possible and could be

facilitated through CEOS, in collaboration with the Office of Outer Space Affairs, relevant non-governmental organizations and the industry.

139. To increase the awareness of policy and decision makers concerned with the protection of the environment, it would be useful to establish a comprehensive list of distributors of raw and processed data from Earth observation satellites as well as analysed information.

140. In order further to coordinate ongoing and planned initiatives relating to Earth observation, it would be useful to prepare a comprehensive list of such initiatives taken at the national, regional and global levels. To minimize duplication of effort, participation in any of the ongoing and planned initiatives should be open to all countries that can make contributions to the achievement of the goals of those initiatives.

141. An appropriate mechanism should be evolved for synergistic cooperation and coordination between the Committee on the Peaceful Uses of Outer Space, with its secretariat, the Office for Outer Space Affairs, and other international bodies working in the space field, including the United Nations Environment Programme (UNEP), the Global Environment Facility, FAO, the United Nations Educational, Scientific and Cultural Organization (UNESCO), WMO and WHO, in particular on critical issues such as global warming, climate change, human health problems and sustainable development, and with CEOS on the coordination of satellite missions.

B. Facilitating and utilizing communications

(a) Status: communications and broadcasting

142. The economic growth rate of the developing regions will be significantly accelerated by affordable telecommunication services. Satellite communications systems reduce the need for terrestrial infrastructure and shorten the time required to establish basic and advanced communications in rural areas. Broadband satellite services are ideally positioned to allow those regions to leap directly into modern infrastructures. Satellite communications could also be the key technology to bring developing countries to participate in the process of building up the global information infrastructure (GII).

143. In the past decade, satellite communications and broadcasting have changed significantly in terms of capacity service offerings, lower space segment and ground equipment costs. The technology has progressed rapidly from small, low-power satellites with low-gain antennas to large complex platforms with high transmission power, precise pointing, a very high degree of frequency reuse and longer design life. Ground terminals have evolved from 30-metre antennas to small and even hand-held units. Along with the advances in technology has come the progressive emergence of new telecommunications services and applications.

144. Optical fibre technology has vastly increased the capacity and cost-effectiveness of land lines, especially for high-capacity and interactive use. However, satellite systems still have certain advantages over fibre-optic systems, including (a) mobility—mobile users cannot be connected to the fibre network directly; (b) flexibility—a terrestrial infrastructure is extremely expensive to restructure; and (c) cost-effective solutions for rural and remote connections—it is not cost-effective to deploy high-capacity fibre networks in areas with low-density traffic and difficult topography. Thus, satellites and wireless technologies will be important in the future implementation of GII.

145. Newly proposed or enhanced services via satellite include voice, data, video, imaging, video teleconferencing, interactive video, digital audio and video broadcasts for entertainment and other uses, multimedia and global Internet access. A wide range of applications are planned, including distance learning, corporate training, collaborative workgroups, telecommuting, telemedicine, electronic commerce, wireless backbone

interconnection (that is, wireless local area network and wide area network), direct-to-home video and satellite news-gathering, as well as the distribution of music, software, scientific data and global financial and weather information. Satellite-based systems are also indispensable for disaster prevention and emergency relief communications services. Those capabilities make it possible, in particular for developing countries, to find solutions to problems of global and regional significance and to support development.

146. Satellite systems are uniquely suited to strengthening the development and extension of distance education. Through such advanced broadband applications as the Internet and two-way interactive video conferencing, local elementary and high schools, universities, libraries, corporations, worksites and multi-purpose information centres can select courses from a wide range of subjects to create or supplement their own curricula.

147. Widespread access to medical facilities for both critical and preventive care is limited in many countries because of geographical constraints and other factors. Satellite technology has tangible applications in telemedicine that could help to extend access to health-care professionals throughout the developing world. Telemedicine applications have been used in emergency situations, for instance during the conflict in Bosnia and Herzegovina, where a 24-hour hospital assistance service was provided. Recognizing the powerful link between medical care and satellite communications, several international health organizations already exchange health and medical information for research, education and other purposes.

148. Communications for rural areas constitute a key element in development efforts. In rural and remote areas, where resources for education and health services can be suboptimal, access to advanced telecommunications facilities could lead to the development of shared resource centres or community access points. Equipped with satellite terminals, the multi-purpose community centres could serve as principal access points for broadband communications. In many instances, those centres could be located within schools or hospitals and shared by multiple users.

149. Satellite communications are also vital in disseminating timely information on improved agricultural practices, agricultural products, prices of commodities, integrated pest management, public assistance measures, banking and credit services—most of which are directly relevant to the development of rural areas and should therefore be treated as matters of the highest priority. Nevertheless, in spite of relatively low costs, in many instances the setting-up of space communications segments for rural communities will still be commercially unattractive. In such cases, there is a need for the intervention of government agencies to establish rural communication services, because the societal benefits to be derived far exceed the direct cost of providing the services.

150. Recent technological developments have enabled the development of a new type of satellite communications system using earth terminals that are small and relatively inexpensive to manufacture. The new systems are generally known as global mobile personal communications by satellite (GMPCS).

151. GMPCS represent a new possibility in personal telephony, including global mobile faxing, messaging data and even broadband multimedia, providing connectivity via small, hand-held phone sets, computer terminals or laptops. They are based on constellations of satellites capable of providing telecommunication services directly to end-users anywhere in the world.

152. It is anticipated that more satellites will be launched in the next 10 years than have been put in orbit over the past 30 years. Nearly 800 of the projected 1,100 communications satellites over the next 10 years will be for mobile systems. During the past five years, the worldwide growth rates for mobile telephony have hovered at an astonishing 50 per cent per annum and some countries are now actually doubling their mobile subscriber base every year.

153. Apart from enhancing the way in which business is conducted, the satellite communications sector is in itself of utmost significance to the world economy. The world market for satellite communications is distributed between a space segment (satellites, launchers and control stations), a ground segment (end-user terminals and networks) and services. With the expansion of direct-to-home television and digital audio broadcasting services and the introduction of personal communications and multimedia services, the ground segment is expected to grow by millions of users per year. The total global market for satellite communications over the period 1996-2006 can be estimated at over $600 billion.

154. Over the next decade, as a result of the convergence of telecommunications, informatics and audio-visual media technologies, the telecommunications sector will undergo fundamental change. New markets will emerge and market demand will increase owing to the opening of markets to free competition and the globalization of telecommunications equipment, network and services markets and the privatization of traditionally state-owned telecommunications operators, in conjunction with the widest application of the relevant 1997 agreements of the World Trade Organization. Those factors are fuelling demand for telecommunications infrastructure and satellites will often be the most cost-effective solution to meet the needs of growth, in particular in developing countries.

(b) Issues and concerns

155. The revolution in information technology, combined with that in communications, has led to a tremendous increase in capacities for information collection, storage, processing, retrieval and distribution. While that has had a great many positive effects, it can also widen the gap between those who use the technology and those who do not in terms of the amount and timeliness of the information to which they have access. Fortunately, there is evidence that the same technological tools can be used actually to narrow the information gap. Steps need to be taken to address the issue of the information gap between countries.

156. One vital necessity, if the information gap is to be reduced, is universal access to communications and information sources. That involves ensuring access to broadcast signals and to telephony. Technology can now provide television signal and telephone connectivity to any person on Earth, practically irrespective of his or her location. Methods of translating that possibility into reality are an important issue that needs immediate worldwide attention.

157. Access to a low-cost bandwidth will be a factor as essential to economic development in the twenty-first century as cheap power was to the industrial revolution in the twentieth century. It is estimated that to meet such a challenging task globally by terrestrial means, 25 years and $1,000 billion to $3,000 billion would be needed to connect the globe with fibre optics. This is where new satellite communications technology could be most useful, in particular in rural areas with low-density traffic of less than 200 subscribers per square kilometre, and may be the means by which developing countries obtain ample, low-cost access to high-density broadband telecommunications links.

158. Radiocommunications systems are the fastest-growing sector of the telecommunications industry. Other radio-based services such as paging, subscriber radio and television delivered by satellite and global positioning systems are also enjoying rapid growth in many world markets. With increasingly sophisticated systems for navigation, air and maritime safety, new laptop-computer-based mobile data systems, proposed services such as GMPCS and dozens of other new applications still being developed, the allocation of radio frequencies in the electromagnetic spectrum has become a pressing issue. The issue led to a fundamental review of the planning and coordination framework of the International Telecommunication Union (ITU), which resulted in the adoption of important decisions at the World Radiocommunication Conference in 1997.

159. The work of allocation and coordination of geostationary satellite orbital positions and the associated frequency bands for the various space radiocommunications services by ITU needs to be fully supported and its effects on developing a more efficient and equitable distribution of spectrum-orbit resources need to be encouraged, taking into account possible technological innovations, in order to ensure access to and use of such resources by developing countries.

160. Radio is the most ubiquitous communications device in the world. There are over 2 billion radio sets in existence and over 100 million sets are sold every year. A leading company in the space industry is attempting to bring low-cost but high-quality digital radio broadcasting to 3.5 billion people, relying on a digital audio broadcasting system that works by routing a radio signal through a very small aperture terminal up to a geostationary satellite. The satellite retransmits the signal, which is picked up by millions of portable radio receivers.

161. The new global digital radio broadcasting infrastructure being created will enable broadcasters and advertisers to reach under-served, emerging markets in Africa, Asia, Latin America and the Caribbean and the Middle East. With a new type of radio needed to receive programmes from satellites, people in those areas will be able to receive digital sound broadcasting of unprecedented quality and diversity.

162. The proliferation of low-Earth orbit (LEO) communication satellites, designed to provide high-quality global personal communications services, have advantages over geostationary satellites in that such satellites would not have the associated problems of long propagation delays and high-latitude coverage limitations. However, LEO satellites usher in a new technology element and the need to maintain multiple technology services could present challenges for developing countries.

(c) Specific action programmes

163. The following specific actions should be taken:

(a) Promotion of the establishment of the necessary legislative and regulatory frameworks to facilitate investment in the telecommunications sector;

(b) Assistance to developing countries in assessing how space technology can help meet their information and communication needs;

(c) Facilitating the sharing of experience between countries in the use of satellite broadcasting and communications for educational and development purposes;

(d) Study of the feasibility of international and regional cooperative systems for satellite-based broadcasting and communications for development.

C. Improving and using positioning/location capabilities

(a) Status: navigation and positioning/location using satellites

164. Global satellite navigation systems are space-based radio positioning systems that provide 24-hour three-dimensional position, velocity and time information to suitably equipped users anywhere on the surface of Earth, and sometimes off the surface of Earth. Global satellite navigation systems use satellites as reference points to calculate positions accurate to within metres or, with advanced techniques, to within a centimetre. Location systems, on the other hand, make it possible to determine the position of a moving object fitted with a tracking beacon. As soon as the beacon comes into operation, the messages that it emits are recorded on board

a satellite and then relayed to the user when the satellite is within sight of a ground station. This is how the COSPAS-SARSAT system operates (see para. 99).

165. There are currently two global satellite navigation systems, the United States' GPS and the Russian Federation's GLONASS (see para. 45). Since their inception, the use of signals from those two existing military satellite navigation systems has been offered free of charge to civilian users. GPS is fully operational, consisting of 21 operational satellites and 3 active spares in orbit. GLONASS is still under development, with 13 operational satellites at the present time.

166. Satellite navigation and positioning services are used largely, but not only, in the field of transport. New applications have emerged in a wide variety of fields, however. The future of global navigation systems is to a large extent unlimited, as new applications will continue to be created as a result of technological evolution. The social and economical benefits of the navigation signal are enormous. Even if transport is currently generating most of the interest around satellite navigation, other sectors, in particular traffic management and agriculture, will account for most of the revenue in the short and medium term.

167. GPS receivers have been miniaturized and their costs drastically reduced, making the technology accessible to virtually everyone. GPS technology has matured into a resource that goes far beyond its original design goals: GPS receivers are now used by scientists, sportsmen, farmers, soldiers, pilots, surveyors, hikers, delivery drivers, sailors, dispatchers, lumberjacks, firefighters and people in many other professions in ways that make their work more productive, safer and easier. GPS equipment is being built into cars, boats, planes, construction equipment, film-making gear, farm machinery and even laptop computers.

168. To improve the positioning information of the current GPS and GLONASS civil signals, the European Commission, ESA and the European Organization for the Safety of Air Navigation (Eurocontrol) have together begun to implement an initial global satellite positioning system, referred to as the European Geostationary Navigation Overlay System (EGNOS). EGNOS is based on a regional augmentation of GPS and GLONASS and will employ navigation payloads on geostationary satellites. In addition, Europe has proposed to initiate work on an independent follow-on system, Global Navigation Satellite System-2 (GNSS-2).

169. The European system is intended for use in many disciplines, from agriculture to transportation, and will meet civil aviation navigation requirements for all phases of flight, from en route to precision approach and landing—the strictest of all satellite navigation user requirements. Benefits of more accurate positioning information for civil aviation include a reduction in the number of accidents, better navigation in all weather conditions and better traffic management. Acceptance by the airline industry of global satellite navigation systems as a navigation aid, however, will be influenced by the guaranteed open access to enhanced positioning information. Currently, most civilian GPS users do not have access to the more precise positioning signal available to military and authorized civilian users, although the GPS civil signal is available to all users free of charge.

(b) Issues and concerns

170. With the availability of high-resolution images from satellites, precision of locations is required to sub-metre levels. Currently, through sophisticated techniques involving repeated measurements, such precision is achievable from the positioning satellite systems. Establishing user-friendly, precise transformation and linkages between the images, GPS observations and their input into GIS databases will be a critical need in the coming years.

171. A major technical issue associated with the use of GPS is the fact that cross-correlation between the data that GPS employs to national data would require the establishment of a geodetic network based on GPS

observations. That becomes very relevant when satellite images, in particular high-resolution images, need to be referenced to national map bases. The cross-correlation and establishment of a different geodetic network means additional investments, both in resources and in time.

172. Although some Governments have already approved the use of GPS in aviation, the performance of GPS and GLONASS does not meet all requirements of civil aviation in all countries and needs to be enhanced through the implementation of system overlay or system augmentation.

173. A number of political and economic problems also need to be resolved before any new type of satellite navigation system can be deployed on a global or regional basis. To overcome those problems, the current GNSS-2 initiative will have to focus more on a clear definition of its mission, operational structure and cost-benefit ratio than on the technologies to be applied.

(c) Specific action programmes

174. A large degree of regional and global cooperation is essential to achieving a seamless multi-modal satellite-based radio navigation and positioning system throughout the world. In that context European entities have started coordination contacts with several countries and organizations, with two objectives. Firstly, to examine the possible extension of the EGNOS coverage to other countries or, alternatively, to ensure its compatibility with other regional augmentation systems. Secondly, to study forms of cooperation in view of the implementation of a second generation system.

175. Further international coordination and consultation is necessary to ensure compatibility between existing and planned navigation and positioning systems while maintaining open access to the satellite signals. At the same time, the technical issues related to using the positioning signal in Earth observation applications require work by groups of technical experts to make the establishment of the necessary geodetic networks more user-friendly.

D. Furthering knowledge and building capacity

(a) Status: space science and space exploration

176. The ability to develop space science or even use space technology depends critically on the availability of human resources with appropriate knowledge and skills. Space research and education address both the understanding of basic space sciences as well as the fundamentals that lie behind the use of space technology for various applications. In a complementary role, training addresses how a technology is used. Thus research, education and training are the cornerstones for furthering knowledge and are part of overall capacity-building.

177. Perhaps the primary benefits of the new age of discovery relate to the impact made on the way in which humankind views its own global habitat in the context of the solar system and the universe beyond. The recognition that human beings are not the centre of the universe but are part of a greater natural order represents a dramatic change in human attitudes towards the world around them. The new appreciation of the interdependence of human beings and their natural environment has inspired a vast expansion of interest in, and study of, the natural environment, including other planets, stars and the universe as a whole.

178. The United Nations, through the Office for Outer Space Affairs, and ESA have jointly organized a series of workshops on basic space science since 1991. The implementation of the recommendations of those workshops has strengthened the scientific infrastructure in developing countries. One of the proposals from the workshop participants is the concept of a world space observatory, a small satellite mission focusing on the

ultraviolet part of the electromagnetic spectrum, with international participation, including that of developing countries.

179. In addition to the many basic research areas indicated in paragraphs 57 to 81 above, knowledge needs to be advanced further in several other space-related areas. In particular, protection and preservation of the space environment should be the subject of constant attention and continued research. For instance, there is a need for further understanding of the orbital debris population (including the size range of debris, its composition and its distribution by orbital altitude) in order to assess the debris hazard to spacecraft in all orbits and to enable decisions to be made on mitigation measures to reduce future hazards.

180. Studies on near-Earth objects received an important impetus with the discovery of the iridium anomaly at the cretaceous-tertiary boundary. No other event has so clearly demonstrated the influence of minor objects on the evolution of terrestrial life. The introduction of studies based on the fossil record has broadened the interdisciplinary and international nature of planetary science, encompassing fundamental concepts of Earth's history, mammalian evolution and contemporary natural hazards both on Earth and in space.

181. The impact of comet SL-9 fragments on the planet Jupiter in 1994 and the recent discovery of asteroid 1997 XF 11 reminded the international community of the existence of about 1,700 suspected near-Earth objects larger than 1 kilometre in diameter that have not yet been discovered with astronomical telescopes. Some space agencies have already taken initiatives in the detection and characterization of near-Earth objects by acquiring data from spacecraft and ground-based observations and creating an inventory of such objects. Non-governmental organizations, such as IAU, also coordinate activities for the detection of near-Earth objects at the international level.

182. Promoting scientific literacy worldwide is one of the great challenges for the new millennium. Much of the quality of life and economic growth now depends on scientific and technical awareness and the ability to incorporate new knowledge and devices into the economy and lives of individuals.

183. The study of space science and planetary exploration is critical to further knowledge in the basic research areas referred to above. In a broader sense, it can make very important contributions to the future well-being of humanity, for the following reasons: (a) it is a basic element of education; (b) it leads to and facilitates international cooperation; (c) it leads to technological development; (d) it promotes the participation of young scientists and engineers in space-related fields; and (e) it enhances understanding of the past and develops a vision for the future.

184. Within space science, astronomy has long been a pace-setter in encouraging education in science and the development of scientific literacy, in communicating science and mathematics to the public, and in motivating children to learn those subjects. Through the World Wide Web, other Internet services and the mass media, the findings of space science and planetary exploration as well as the economic and social benefits that eventually derive from them can now be made more readily available to all people.

185. In terms of education, the space sector will always need young graduates in space-related fields from all levels of university education in a wide range of disciplines, including science, management, law, engineering, economics, architecture, communication, medicine and finance. Space agencies, commercial firms and international organizations involved in space emphasize that many young specialists should complement their training by acquiring the tools that will enable them to increase their efficiency in an interdisciplinary, international and consequently intercultural environment.

186. A strong and well-developed conventional system of education, from primary to university levels, can provide a good foundation for introducing or carrying forward work related to space science and technology.

A number of space agencies and institutions prepare, on a continuing basis, audio-visual material to strengthen the science, technology and mathematics components of existing curricula at all educational levels. Many such institutions organize training courses on various subjects. Some of them are also involved in providing adequate educational support for teachers.

187. A large amount of educational material, essentially covering all aspects of space science and technology, is being continuously developed. Examples of institutions that prepare such materials include the National Institute for Space Research (INPE) of Brazil, the British National Space Centre, the Centre national d'études spatiales (CNES) of France, ESA, DLR, the National Aeronautics and Space Administration of the United States of America, the National Space Development Agency of Japan, the Russian Space Agency and several other space agencies. Although the material is developed primarily to meet national needs, as a result of cooperative arrangements much of it is benefiting a large number of countries.

188. Educational material is also developed by other institutions including international organizations such as CEOS, the Committee on Space Research, the International Council of Scientific Unions (ICSU), the International Astronautical Federation, IAU, the Planetary Society, organizations in the United Nations system and other professional scientific organizations throughout the world that promote the benefits of space science and technology.

189. In addition to education and training of human resources, capacity-building involves developing experience and practice in conducting research programmes or operational applications of selected technologies. That involves setting policies, establishing institutional frameworks and physical infrastructures, ensuring funding support for the chosen activities and access to external sources of data and information, as well as establishing technical cooperative links with institutions having expertise in the selected areas of research or applications.

190. Experience indicates that as education in the basic disciplines becomes more widely available, the transition from such education to space applications can be brought about by project work, by on-the-job training and experience, by workshops and by joint project partnerships.

191. The Office for Outer Space Affairs, through the United Nations Programme on Space Applications, has undertaken an initiative aimed at establishing regional centres for space science and technology education, affiliated to the United Nations, located in developing countries. The centres are based on the concept that by pooling limited material and highly qualified human resources, developing countries could have education and training centres, of an international-level quality, that will prepare indigenous personnel in the use of space science and technology, in particular those applications relevant to national development programmes such as remote sensing and the use of geographic information, satellite meteorology, space communications and basic space science.

192. The Centre for Space Science and Technology Education in Asia and the Pacific, affiliated to the United Nations, was established in 1995. The first node of the Centre is hosted by the Indian Space Research Organization and offers short-term training courses and nine-month education courses, followed by a one-year follow-up project, in remote sensing and GIS, satellite communications, satellite meteorology and the global climate and space science. By the end of 1998, the Centre had completed five courses and had about 80 student alumni. The Centre hopes to become a nerve centre in the Asia-Pacific region by undertaking specific research projects and consultancy services to the Member States in the region and by providing high-quality education in areas of space science and technology development. To utilize all the potential of the region, interested countries of the region are encouraged to undertake further consultations, with the assistance of the Office for Outer Space Affairs, with a view to creating the network of nodes that are to constitute the Centre.

193. Brazil and Mexico were selected as host countries for the regional Centre for Space Science and Technology Education in Latin America and the Caribbean, affiliated to the United Nations. The agreement establishing the Centre was signed by the two Governments and was subsequently ratified by their respective parliamentary bodies in 1997. The process of establishing centres in Morocco and Nigeria, for the French-speaking and English-speaking countries of Africa, respectively, is nearing completion and plans for a centre in western Asia are also being finalized.

194. In the case of central, eastern and south-eastern Europe, discussions among Bulgaria, Greece, Hungary, Poland, Romania, Slovakia and Turkey led to the establishment of a network of space science and technology education and research institutions. Experts from those countries agreed to work with the Office for Outer Space Affairs, with the support of Italy, to undertake a study on the technical requirements, design, operation mechanism and funding of the network.

195. In support of the centres, the Office for Outer Space Affairs brought together a group of research and education specialists and requested them to prepare international-level curricula in the areas of remote sensing and GIS, satellite meteorology, satellite communications and basic space science. The curricula prepared by that group were sent for peer review to individuals representing a broad geographical and scientific cross-section. The curricula are intended to provide a benchmark for all the regional centres.

(b) Issues and concerns

196. Strengthening and supporting the activities of the regional centres, established at the initiative of the United Nations, calls for concerted effort by various agencies with a view to sustaining, *inter alia*, their educational activities, infrastructure development and the institutional and organizational framework.

197. The development of human resources has to be supplemented by the development of adequate physical infrastructure. The first step in doing so is to define needs, which depends in turn upon the overall needs of the country concerned and the defined or likely role of space science and technology in meeting those needs.

198. While needs and possibilities will vary from country to country, experience indicates that it is best to begin with the infrastructure required for applications, for example, computers and equipment for analysis of remotely sensed imagery, and then to move on (if required) to data reception facilities. Such an approach also helps to produce the quickest returns from investment in such infrastructure and helps to develop and expand local skills.

199. Financing of physical infrastructure is an area where international assistance may be needed. Multilateral agencies can play a major role in providing such financing and in ensuring the inclusion of space-related infrastructure in development projects, for example, by including a satellite broadcasting component in an education project. Efforts should be undertaken at the national level to create awareness about the need to integrate such infrastructure facilities providing support to elements of other larger projects in the development field.

200. Potential users of space technology often need technical advice in identifying the type and appropriate level of technology to include in their programmes. The risks involved for the decision maker are that the chosen technological solution may be insufficient for the problem, and therefore a failure, or that it may prove more sophisticated than was required, resulting in a poor cost-benefit ratio. Such a situation is particularly likely to occur in many developing countries.

201. Space-related organizations with educational activities are turning increasingly to the Internet, and in particular the World Wide Web, for their outreach. But the Web is not yet worldwide, and Internet access is still

limited in some developing countries. While there are programmes that aim at enlarging electronic access for developing countries, printed materials continue to be a requirement.

202. Political and financial support for the development and use of space science and technology is enhanced by improving public awareness, understanding and appreciation of the benefits derived from space. Although every institution involved in space conducts activities of dissemination of information to the public, the results are not fully satisfactory. Higher priority needs to be given to such activities.

203. Operating with less formalism and fewer constraints, and with more limited agendas, non-governmental organizations can serve both as advocates and as team-builders for international cooperation, both at the level of working scientists and at that of the general population. Emphasis should thus be placed on the potential of non-governmental organizations to serve as catalysts in education and public information.

204. The efforts made by space agencies in observing near-Earth objects can be further strengthened by coordinating activities with non-governmental organizations and individual researchers at the global level. Non-governmental organizations can play an important role in providing the general public with accurate information on near-Earth objects.

(c) Specific action programmes

205. The Office for Outer Space Affairs, jointly with each regional centre for space science and technology education associated with the United Nations, should lead an international effort that would include space agencies, specialized agencies of the United Nations system, intergovernmental and non-governmental organizations and the private sector, to build up the quality of education programmes and the long-term viability of the centres. Such an international effort could be strengthened by redirecting some of the cooperation activities that the Office already conducts, as for instance with ESA, the International Society for Photogrammetry and Remote Sensing and the Planetary Society, or by adding other cooperation activities with new co-sponsors.

206. The regional centres should receive the recognition, once earned, of their value in preparing human resources that can support economic and social development programmes. That recognition should assist the development of a self-sustaining funding mechanism for each centre based primarily on support from the region, donor countries, international organizations and private industry. Awareness-raising efforts by alumni would be a key element in achieving that goal.

207. Possible action in direct support of the education programmes include the following:

(a) Promoting the establishment of cooperative agreements between the centres and the types of entity mentioned above. The educational areas and form of cooperation would be the subject of arrangements, at the university level, on a mutually acceptable basis, whereby researchers and lecturers could be exchanged, technical advisory support provided for graduates conducting pilot projects in their home countries and short-term courses and workshops designed and organized to develop capabilities of the participants beyond the basic introductory level;

(b) Promoting the acquisition by the centres of audio, visual and available on-line educational materials;

(c) Assisting the centres in achieving a significant representation of regional and international lecturers;

(d) Assisting the centres in directing some of their activities to areas of regional and international concern;

(e) Establishing a fellowship fund or mechanism to support the participation of individuals from the regions in the education and training programmes of the centres.

208. Other actions to strengthen the infrastructure and operation of the centres could include the following:

(a) Assisting the centres in preparing cost-sharing proposals to funding institutions for initial operations;

(b) Assisting the centres in establishing contacts with industry that would lead to partnerships in areas of common interest;

(c) Assisting the centres in designing an effective means of disseminating information about their accomplishments, at the regional and international levels, so as to build up the requisite support to ensure their long-term viability;

(d) Assisting the centres in utilizing educational materials and training possibilities available through the Internet and World Wide Web, as well as in exchanging materials and programme experiences among themselves.

209. The costs involved for the United Nations would be primarily in terms of staff work-months, which could be covered within existing resources of the Office with some modest costs. The time-frame for the activity would be three years. In consultation with the participating institutions, the Office would report to the Scientific and Technical Subcommittee on progress made.

210. The United Nations has been effective in distributing information and enhancing communications for scientists and educators in developing countries. It could also lead initiatives to distribute educational material incorporating the latest information and results from space exploration. The support of national space and science agencies, educational organizations and non-governmental organizations for the development and distribution of the material is crucial.

211. Interested countries could provide expertise and participate in missions and other space activities, not only through educational programmes, but also by contributing to and developing space mission databases, instruments and components, by providing co-investigators in scientific or engineering teams and by manufacturing or production efforts. To that end, the various “announcement-of-opportunity” invitations to participate in research or pilot projects that are regularly issued by space agencies should be widely disseminated.

212. In addition to its emphasis on space applications, the United Nations could develop programmes of information and training, based on the results of and activities in space science and planetary exploration, for the benefit of developing countries. Workshops and symposia to assist scientists in responding to opportunities to participate in a space mission, as well as to benefit educators and others interested in the broader issues related to space science and planetary exploration, could be convened within the framework and resources of the United Nations Programme on Space Applications.

213. A staff member of the Office for Outer Space Affairs could act as international coordinator to facilitate the participation of scientists and engineers from developing countries in major space-related international projects and programmes. Workshops and symposia for scientists and educators from developing countries

should continue to be organized to facilitate their participation in space science missions and benefits. Such workshops should examine and build upon the results of previous events.

214. Greater coordination of observations to inventory and characterize near-Earth objects, with the involvement of non-governmental organizations, individual researchers and amateur astronomy groups, including those in developing countries, should be undertaken. The space agencies that already have activities to observe near-Earth objects and IAU should play a leading role in establishing a coordination mechanism for such observations, as well as for public notification should an object posing a significant hazard to Earth be discovered.

215. The Office for Outer Space Affairs, within the framework of the United Nations Programme on Space Applications, could organize international meetings of leading researchers in the fields of astronomy, planetary science, astrophysics, palaeontology, astronautics and space law on near-Earth objects on a regular basis, for example, every two or three years.

E. Enhancing education and training opportunities for youth

(a) Status: the importance of space education and training for youth

216. Continuous development of human resources is crucial to ensuring the scientific and technological as well as economic, social and cultural development in any country. Human activities in some fields are characterized by rapid developments in science and technology, expanding beyond national boundaries with significant social, economic and cultural impacts on the global society. For those activities, strategies for developing human resources should be based on broad and long-term perspectives for future directions of human activities. Developing such strategies would require international cooperation in enhancing educational opportunities for future generations in order to enable them to meet the diversifying needs of future societies.

217. As stated in Article 55 (b) of the Charter of the United Nations, the promotion of international educational cooperation is one of the important objectives of the United Nations. Through the programme on the peaceful uses of outer space, the United Nations continues to provide educational and training opportunities to learn about space science and technology and their applications, in particular by carrying out activities of the United Nations Programme on Space Applications. Some of those activities could also benefit young people, who will be future policy and decision makers.

218. Some space agencies organize activities for young people in their countries, motivating them to study more about space science and technology and to think about working and living in space. There are also non-governmental organizations of young people interested in space activities, such as the Young Astronauts Club, which not only organizes space-related activities for young people but also helps them make contact with their counterparts in other countries. Such educational activities not only help encourage future scientists and engineers to pursue their career in space-related fields but also contribute to increasing the overall scientific scholastic aptitude level. Some activities organized by space agencies and non-governmental organizations in some countries can be considered as models for educational and training activities for young people in other countries.

219. Many initiatives taken in space activities require much time to achieve their objectives, from the development of the mission concept to the accomplishment of the missions defined. Planning of space activities should therefore be accompanied by appropriate long-term strategies for human resource development. In view of the increasing international cooperation in space activities and the growing importance of socio-economic benefits of space applications, educational activities for future decision makers and managers should emphasize the importance of cross-cultural experience and interdisciplinary training.

220. In that regard, the activities of the International Space University have proved to be successful. At its annual summer session, about 100 young people of about 25-35 years of age from many parts of the world receive 10 weeks' interdisciplinary training, studying the basics of various aspects of space activities, ranging from space manufacturing to space law and learning to work together in a cross-cultural environment. The University now offers a one-year master's programme and organizes short-term courses for young professionals. Its educational activities are also expanding to include more participants from developing countries. One of the main objectives of the University is to train future leaders in the space community. It has been particularly successful in that regard, with its growing network of alumni active in various space agencies and space-related research institutes, international organizations and industries.

(b) Issues and objectives

221. The participation of young people in the educational and training activities of the United Nations Programme on Space Applications is still limited. While the United Nations should continue to provide educational and training opportunities for policy makers, scientists and engineers who would have direct and immediate impacts on the socio-economic development in developing countries, the United Nations, in collaboration with other relevant organizations within the United Nations system, could provide educational and training opportunities for students and young scientists and engineers who will become future space leaders around the world. This would contribute to developing the human resources necessary to ensure the continued utilization of space applications for economic and social development.

222. As the younger generation will be affected by the plans currently being developed for space activities, efforts should also be made, whenever possible, to provide young people with opportunities to express their ideas and visions for such activities. The international space community could also benefit from their unique and innovative ideas, which are not bound by the established policies and official positions of Member States or international organizations. At the same time, if encouraged to participate in an international forum where a blueprint for international cooperation for space activities is prepared at the intergovernmental level for the coming century, young people could be motivated to turn the blueprint into reality.

223. In the light of the above, the Preparatory Committee at its 1998 session agreed that the Youth Forum should be organized as one of the components of the Technical Forum of UNISPACE III. Events for undergraduates are planned by the European Association for the International Space Year (EURISY). For graduate students and young professionals, the International Space University's alumni associations will organize parallel sessions with UNISPACE III, with the aim of presenting to the decision makers in the current space programmes the visions and perspectives of young space professionals around the world concerning future space endeavours.

(c) Visions and perspectives of youth

[The outcomes of the youth events will be summarized and inserted here.]

F. Information needs and the global approach

(a) Status: information systems for research and applications

224. Information systems are fundamental tools for organizing, handling and integrating data through appropriate algorithms and for generating output in the form most suited to the intended user group. Information technology includes a cluster of advanced technologies in the fields of computing, software, microelectronics, telecommunications, databases and networking. Thus information technology in this wide sense includes not only information-relevant processing technologies but also telecommunications and electronic information

transfer technologies. The emergence of space technology as a potent tool for information gathering and for rapid and reliable communications over long distances and to remote areas has been a major contribution to the information technology sector.

225. The changing scenario of the information technology industry and the proliferation of computers has changed the scope of information processing, whether in terms of applications or for technology support. Computers are currently not only able to process text and numbers, but also digital maps and images, both by themselves and along with tabular data, and to merge them together to provide a new perception—the spatial visualization of information.

226. Information infrastructures have become an essential element of the development of any country. In the global sense, the concept of a GII is being conceived on the basis of the vision of open connectivity and information access. The thrust of a GII is open access, universal service, a flexible regulatory environment, competition and private investment. The fundamental principle underlining a national information infrastructure is the "right to know" and the "right to information" tenet. The right of access to public domain data, consumer data, citizens rights, universal access and financial data underpin the need for developing a national information infrastructure.

227. Information systems are the core of national and global information infrastructure. While it is not essential to organize multiple information systems for the global and local levels, what is needed is an abstraction and exchange mechanism for the aggregation of information from lower to higher levels. Many countries have national infrastructures for information where the access to information is recognized as a basic right, while many developing countries have yet to establish information infrastructures and lack the recognition of access to information as a basic resource for development. The essential existence of databases as prime tools for decision-making and development needs to be demonstrated with concrete examples of their cost-effectiveness in organizing information and assisting with analyses.

228. For effective planning and development, a variety of data on physical and natural resources, human resources, social practices and economic aspects are required. Databases organized around GIS cores are essential elements of the information systems and the emphasis in the future will be on organizing spatial databases using GIS. Space images will be the most important form of inputs for the GIS databases, as they record the continuum of changes in the environment. The modelling and integration capabilities of GIS allow quick and reliable analyses of "what-if" scenarios of real and possible situations and generate visualizations of queries that users specify.

229. An important asset of GIS is their data handling capacity. Firstly, they allow the input of data of different origin, content and format. Secondly, they offer to the operator wide flexibility in manipulating the data and displaying it in a user-appropriate form. Finally, they permit the integration of data in a value-added product, the information content of which is higher than the individual items of data and is customized to meet user needs. The power of those tools depends not only on their technical characteristics, but also on the quality of input data and in particular on the capability of keeping the database up to date by including new data. Earth observation from space provides a coherent, objective and regular source of input data for information systems.

230. Information systems are therefore of value for monitoring purposes, for event observation and for planning and prevention activities. They are valuable tools for both research work and application activities, and eventually in decision-making.

231. Information systems are also needed for education and training as they facilitate the transfer of know-how from developed to developing countries and institutions—a prerequisite for sustainable development. All levels of training need to be considered and ensured for technical specialists, data interpreters, students and professors,

decision makers and project managers. Furthermore, on-the-job training and course follow-up activities are necessary.

232. Prime databases have now become accessible through the World Wide Web, creating a demand for compatibility of Web databases and for universal access. In turn the new technology has brought with it calls for standardization and low-cost tools.

233. As various new information systems have been developed, the protection of intellectual property rights has become one of the most debated issues, as reflected in the discussion of international action to ensure worldwide protection of intellectual property in databases. Various legislative initiatives have been proposed regarding intellectual property rights.

(b) Issues and concerns

234. An important step in solving problems of global and regional significance is to identify the issues relevant to major global problems and concerns such as ozone depletion, coastal changes, climate change, extreme weather phenomena, reduction in biodiversity, desertification, deforestation and land-ocean-atmosphere interactions, in particular the El Niño phenomenon, in which space technology could contribute to the understanding and solution of problems. At the local or national levels, the emphasis would be on using high-resolution satellite images to provide solutions for more mundane issues of direct relevance to the local people—crops, water, land use, urban growth, routing of facilities, pollution and so on. A common factor in all those problems is the need to have integrated information systems existing in a distributed manner but linked through powerful networks able to serve as the "backbone" for national developmental and global research activities.

235. For most of the research and developmental application needs related to environmental issues, the sources of information are the same, namely, field observations, ground measurements, remote sensing data taken by airborne and space-borne sensors, ancillary inputs from archives and databases and additional information based on experience and from statistics. However, although many data products are being created by government, university and other research groups, the products are often difficult to find, fragmented and poorly documented, or they are unavailable in a suitable medium or an easily readable format.

236. The issue of metadata for data access, search and exchange is a key issue if information access is to be universal. Development of information locator engines for easy search and access and getting to the right information is also essential.

237. As policy makers turn their attention to designing a sustainable development approach to management of the problems of Earth and its resources, data and information are urgently needed in a readily accessible and easily understandable form. Recognition of the usefulness of spatial information (information in map form) for decision-making and its inputs for spatial area-based planning and development is, with a few exceptions, lacking in developing countries. Such a situation needs to be corrected in order to improve the decision-making process.

238. When discussing the compilation of data and their inclusion in information systems for the benefit of human development, the two key issues to be considered are that user requirements must first be defined and that there should be continuity with respect to both data and services.

239. Another issue concerns the protection of intellectual property rights. With the increasing sophistication of data-processing techniques used in observation systems, more organizations, including commercial organizations, will be supplying the observation systems, data-reduction capability and value-added products.

The intellectual property issues relating to environmental information are complex and changing, requiring careful policy attention. Consideration should be given to the possibility of developing a set of appropriate measures to protect intellectual property rights without limiting opportunities to make the resulting data and information available not only for the primary uses, but also for all other beneficial purposes such as research, bearing in mind that the issue of intellectual property rights comes under the jurisdiction of the World Intellectual Property Organization.

(c) Specific action programmes

240. Specific actions are needed to establish an all-encompassing information infrastructure consisting of:

(a) *Databases*. The key elements of the infrastructure are the databases and developing databases for different purposes and users (private, public, scientific and government) is the major task to be accomplished in a systematic development of infrastructure. In most countries, the emphasis will be on converting the massive amounts of analog data to computerized databases;

(b) *Network*. The basic element in the operation of an information system is the backbone on which information travels from one point to another. With rapid advances in technology, network configurations are evolving to provide high-bandwidth connectivity using fibre optics and various technologies to reach data transmission rate capacities of up to 100 megabytes per second, communication networking of up to 2 megabytes per second with very small aperture terminals and high-speed satellite broadcast delivery. The network backbone will therefore have to be a mix of satellite and terrestrial communications. The advantage of satellite communication is its regional reach and its ability to serve miniature hubless very small aperture terminals and direct-to-home delivery of information services;

(c) *Standards*. Standards for databases (formats, exchange of data and interoperability) and networks (gateways and protocols, communication equipment and software) are an important element of information systems. Standards enable applications and technology to work together. Users must be closely involved when standards are developed, since the final product should be user-friendly. The adoption and use of standards also require resources. The adoption of standards can be slow, in part because those who reap the benefits of standards are often not those who have borne the cost of creating and implementing them. Governments can encourage the adoption of standards by requiring their use;

(d) *User interface*. With regard to the design of information systems, much depends upon the type of user who is intended to have access to the system and the upper-end level of applications or services available on it. For some applications, penetration will have to reach the household level and capabilities will include on-line access to video applications, such as for education programmes using the Internet.

241. The availability of clear and up-to-date information on technical issues and application results is essential if the full benefit is to be derived from the use of space science and technology. Participation in thematic workshops and conferences and access to the international e-mail network and the Internet should also be supported.

G. Spin-offs and commercial benefits from space activities—promoting technology development and exchange

(a) Status: commercial and spin-off activities

242. Space activities incorporate some of the most important areas of high technology: computer software and hardware development, sophisticated electronics, telecommunications, satellite manufacturing, life sciences,

advanced materials and launch technology. Space activities also involve some of the most significant issues of international trade and policy: global markets, gaining access to remote areas, government-subsidized competition and international standardization and regulation.

243. Products and services derived directly from space technology as well as indirectly from the large number of its spin-offs contribute in many ways to improving the quality of life of society. Some benefits are provided directly by the technology, as in the case of telemedicine, tele-education and emergency communications. Other benefits are found in thousands of spin-off products that have resulted from the application of space-derived technology and are used in such fields as human resource development, environmental monitoring and natural resource management, public health, medicine and public safety, telecommunications, computer and information technology, industrial productivity, manufacturing technology and transportation.

244. The commercialization of space activities has been a highly positive development. Through numerous joint ventures, including those with companies from developing countries, commercial systems and services are creating, for example, expanding constellations of communications satellites. These constellations of satellites have relied successfully on the international private sector to provide financial investment and to manufacture, operate and market satellites and services. Remote sensing and other areas have also depended on, and received, private sector investment in some cases.

245. Satellite telecommunications constitute the most mature segment of the space market. According to some studies, from 262 to 313 communications satellites are to be placed in geostationary orbit between 1996 and 2006, with an estimated market value of $24 billion to $29 billion. To estimate the full potential market, the corresponding figures for low- and middle-Earth-orbit satellite constellations for mobile telephony and multimedia applications would have to be added.

246. The development of a launch vehicle capability is an activity initiated by Governments and later transferred in large part to commercial launch enterprises, which have created a lucrative commercial market. The satellite launch market, estimated at $45 billion over the period 1998-2007, is increasingly driven by commercial satellite operators in all orbits. The market is still dominated by launch services into the geostationary orbit, which require heavy launchers. New applications, such as digital television, rural telephony, digital audio broadcasting, mobile services and high-bit-rate data delivery services will be provided by larger satellites and will continue to drive market growth.

247. While space agencies and research institutions, both academic and governmental, are expected to double the demand for small expendable launchers, driven primarily by the boom in small to nano-satellites, the demand for launchers from the commercial sector will be even larger and will be driven by larger constellations using heavier satellites to increase productivity. This is expected to continue to be the trend for satellites placed in low-, medium- and geostationary Earth orbits. Another trend in launch requirements to all orbits is less costly launch prices.

248. Next to telecommunications, remote sensing and geographic information systems may be among the most significant commercial applications. With the launch of 20 new remote sensing satellites expected by the year 2002, data-collection capabilities will increase considerably. The new systems will provide users with higher spectral and spatial resolutions. That will be combined with an increase in cost-effective computing power and data compression capability. At the same time, applications will be more adapted to specific user needs and more user-friendly.

249. GIS will become an essential tool for analysing data as well as presenting information for market and geopolitical analysis and for diverse applications such as environmental studies and disaster management planning. It is projected that the GIS market could reach $5 billion in sales by the year 2000.

250. Commercial activities for the provision of information services will emerge as a key sector for private investment, with the anticipated demand for information growing between threefold and fourfold. Development of value added to satellite images, their input into GIS databases, modelling and integration for scenario analysis and recommendation of specific actions will be major factors in determining the involvement of the private sector. Commercial remote sensing satellites are planned to offer high-quality data and services to specific user segments. The commercial viability of the data services and their cost are still to be determined.

251. In 1997, the various segments of the yearly worldwide civil Earth observation market have been estimated as follows: $580 million to $620 million for the satellites, including both meteorological and remote sensing spacecraft; $230 million to $250 million for satellite launches; $60 million for sales of raw data; $280 million to $300 million for terrestrial equipment for receiving, storing and processing satellite data; and $830 million to $850 million for data distribution, processing and interpretation services and value-added products and services. Most users of data and services are currently in the government and public sectors, followed by private companies and universities. Within the next 10 years, depending on the development of some promising market segments (such as real estate, utilities, legal services, insurance, precision farming and telecommunications), the market is expected to grow by a factor of three to five.

252. Since 1993, the market for GPS equipment alone has gone from about $0.5 billion to $2 billion in 1996 and is expected to reach between $6 billion and $8 billion in 2000. Civil ground applications, already at almost 90 per cent of the total market, will keep increasing (automotive navigation systems, geodesy, GIS, precision engineering and emerging fields such as precision agriculture). The success is due to the dramatic increase in the accuracy of GPS and to the steep drop in prices of equipment. GPS is thus becoming an enabling technology fuelling the market by offering accurate, real-time positioning data to be integrated with other types of information.

253. The use of GPS has become a true spin-off and its future growth will rely more and more on the consumer market. In fact, GPS services are expected to complete the transition from a stand-alone device to a standard feature integrated into a variety of multifunctional products such as wireless personal communication devices, leading to a mass consumer market with an average selling price per receiving unit of about $100.

254. Not all developments of space technology find their applications on Earth. Still being developed, space manufacturing involves the use of the near-zero gravity and vacuum environment of space for the production, processing and manufacture of materials for commercial purposes. That is a very broad definition, which includes such industrial and research activities as the zero-gravity production of medical supplies, metal alloys, plastics or glass; the processing and analysis of organic matter; and the study of the physiology and behaviour of humans, animals and plants in the unique environment of space.

255. New materials will become possible simply because the absence of gravity allows for the creation of perfectly even and consistent mixtures of materials with vastly different masses and densities. Such alloys would have physical properties that could not be duplicated on Earth and could lead to the production of much faster computers, smaller and much more powerful batteries that could power future electric cars, as well as many other new products.

256. Space might also provide an optimum location for orbiting platforms to be used to transmit energy via optical mirrors and microwave technology. Solar energy or energy from remote sources on Earth could then be directed to the locations where it is needed.

257. Space technology now represents an immensely valuable bank of know-how that is used by thousands of companies worldwide to bring new products, processes and services to the world market at more competitive prices. Such indirect effects of space technology applications, which in the past were considered by-products

of research and development, are seen increasingly as primary effects and as a meaningful element of industrial policy. Non-space industrial sectors are more demanding of new technology, new processes and new materials to remain competitive in their fields. The origin of much of the new spin-off technology can be found in the space industry.

258. Technology transfer and spin-off programmes (that is, programmes that have enabled products and processes to emerge as secondary applications of space technology) developed by national and international space agencies now demonstrate a market-oriented approach based on demand and well identified market segments. Thus, space technology no longer appears to be a luxurious product and process, but rather a reservoir of potential solutions for industry.

259. The simultaneous acquisition, adaptation and assimilation of high-technology knowledge, while perhaps desirable, are not always feasible. Many countries try to overcome that difficulty by adopting strategies that differ according to their political and socio-economic environment and stage of economic development. Scenarios for technology development and exchange vary from questions of "What kind?" and "Where?" to "How much?" Accordingly, many countries are developing strategies not only for applying foreign technologies, but also for initiating the necessary process of securing technological training and self-reliance. Developing countries in particular face constraints in their efforts to move ahead in the high-technology area of space, mainly because of the limited financial resources available, lack of access to basic facilities, lack of knowledge about the technology and limited educational training facilities.

260. The transfer of technology encompasses all activities that culminate in the permanent adoption of new techniques by the recipient. As far as space and space-related technologies are concerned, some of the areas of greatest importance for developing countries involve technologies that are already considered operational technologies in developed countries, the use and development of information technologies being two such areas. The technologies are related to computers, fibre optics, satellites and telecommunications and facilitate, through the use of electronic networks, the rapid transfer, processing and storage of all forms of information and data. Today, those technologies foster globalization by increasingly underpinning all production and service industries. Notable among the priority development and application areas for developing countries are the provision of health and education services and support for agriculture.

261. Another priority area is the development of small- and mini-satellite technology, which has the potential to offer to many countries great possibilities for affordable access to space through the rapid development of fully integrated national space programmes. Until recently, space missions required very complex satellites, developed at high cost, that could only be undertaken by large space agencies. However, the miniaturization of components and the use of nano-technologies in space missions, such as those used in small satellites, offer quick and affordable access to space to countries with small space budgets. Such national mini-satellite space programmes can lead to the creation of new industries and actually improve opportunities for transfer of knowledge both locally and internationally. In addition, mini-satellite programmes develop advanced technologies, which, when transferred to industry, result in tangible benefits to States and to the international community.

(b) Issues and concerns

262. The Declaration on International Cooperation in the Exploration and Use of Outer Space for the Benefit and in the Interests of All States, Taking into Particular Account the Needs of Developing Countries, adopted by the General Assembly in its resolution 51/122, provides a sound basis for the promotion of technology development and exchange.

263. While space provides a whole new realm of opportunity and a vast potential market for industry and business, it is still perceived by many as a final frontier rather than an economic market ripe for expansion. However, a fundamental requirement for the above and many other innovative spin-offs to become reality is the reduction and minimization of development costs, thus making economy and efficiency a primary concern. For instance, in order to stimulate the commercialization of the potential market for manufacturing in space, the cost of developing the basic space infrastructure must be reduced dramatically. Governments would also have to play a role in promotion, giving incentives and aiding the development of a private sector presence in space, making it just another place to do business.

264. The successful transfer of space-related technologies and spin-offs from research and development institutions to industry requires the availability of appropriate methods and infrastructures, as well as clearly defined government policy and support on the matter. The requirements include the following: establishment of organizational structures, dedicated to technology transfer and commercialization, in national space agencies or other government bodies in charge of technological development; stimulation of marketing mechanisms focusing on widespread promotion of technologies and spin-offs; development of financial and tax incentives encouraging innovators, entrepreneurs and investors; and creation of relevant education and training networks.

265. A major concern is insufficient global access to the technology related to acquiring environmental data and information. Enhanced access would, *inter alia*, contribute to the national implementation of international agreements and protocols, facilitate the formulation of national environmental strategies having a global dimension and generally improve policy planning and environmental management.

266. Technology transfer from space-faring countries to developing countries could be promoted by providing more training opportunities for scientists and engineers of developing countries in utilizing off-the-shelf technologies. Such opportunities would be sufficient for the scientists and engineers from developing countries to understand the direction of civil space technology development, which would facilitate the decision-making process in their countries, in particular with regard to prioritizing the space-related research and development activities to be pursued.

267. A favourable environment in the recipient countries needs to be created to allow the transfer of technology to become permanent. Such an environment includes trained human resources in sufficient numbers, appropriate infrastructure and institutional arrangements, a suitable policy framework, long-term financial support and opportunities for the involvement of the private sector in technology transfer initiatives. That would enable space technology applications in developing countries to become truly operational and fully integrated into development activities.

268. Providing such opportunities to developing countries may also expand market opportunities for the space-related industry of space-faring countries. A noteworthy example is that of some developing countries that have made agreements with commercial entities for the transfer of small satellite technology.

269. Although several cooperative, mainly bilateral, programmes exist between developing countries for the transfer of space technology, current mechanisms for fostering South-South cooperation in technology development and transfer are insufficient. Mechanisms through which donor organizations may finance technology transfer projects at the regional level, such as regional information networks, are not sufficient because of policy constraints that heavily favour bilateral agreements. Insufficient experience in preparing and submitting project proposals in the formats and with the information content required by various funding institutions is an additional constraint faced by developing countries.

270. Problems experienced by developing countries in the area of space technology exchange and spin-offs may be summarized as follows:

(a) Limited access to information;

(b) Low number of specialized training centres;

(c) Less efficient national technology transfer infrastructures;

(d) Lack of qualified suppliers;

(e) Insufficient appropriate funding and investment opportunities.

(c) Specific action programmes

271. The effectiveness of current mechanisms needs to be enhanced in order to improve collaboration between countries on development issues as well as on global environmental problems. An effective, pragmatic and affordable approach to technology exchange, consistent with the Declaration on International Cooperation in the Exploration and Use of Outer Space for the Benefit and in the Interests of all States, Taking into Particular Account the Needs of Developing Countries, should be developed. The technology to be transferred should be appropriate for local conditions and arrangements should include provisions for periodic updating. The transfer must combine both know-how and an understanding of the fundamental principles upon which the technology is based. Where appropriate, agreements should take into account the need to protect intellectual property rights.

272. Given the current geographical distribution of space activities, the benefits derived from space through the commercial use of space technology applications, technology transfer and spin-offs are more concentrated in developed countries and in a few of the technologically more advanced developing countries. However, space systems are neutral from a geographical point of view and can be used more by the less developed countries and regions, thereby making a greater impact on their social, economic and human development.

273. Taking into account the importance of adequate access to space technologies and applications relevant to sustainable development programmes in developing countries, as well as mutual commercial benefits available to both providers of technology and its recipients and users, international cooperation in the area of space technology transfer and spin-offs should attract the particular attention of Member States. In that connection, the proper legal frameworks and international agreements being developed by United Nations bodies and agencies, covering such issues as intellectual property rights, trade marks, copyright and foreign licensing, are essential to fostering international cooperation in the area of space technology and spin-offs.

274. Apart from training of human resources at the basic level of science and technology and fostering South-South cooperation, the regional centres for space science and technology education should organize specific training to contribute to the building of local expertise and ultimately to the success of technology transfer programmes.

275. In order to attract the investments that are vital for the success of technology transfer projects, the political will and commitment of national leaders as regards the introduction of new technology and the development of appropriate infrastructure should be apparent. Political, social and economic stability would also greatly enhance the possibilities of foreign investment in emerging markets. Incentives to encourage both foreign and local investors should be given in order to stimulate the adaptation of technologies acquired from abroad to meet local needs.

276. The Office for Outer Space Affairs could initiate a technology outreach programme on space for university educators (TOPS) aimed at the promotion of the successful transfer of space-related technologies by enhancing the ability of university educators in developing countries, in particular the least developed countries, to

incorporate relevant aspects of space technology into the curricula of their institutions. Through its multiplier effect on students, TOPS would lead to a broader local awareness of the benefits of space technology in addressing local concerns in the medium to long term, thus contributing to the creation of a local environment that is more conducive to the permanent transfer of space technology.

277. The effectiveness of many specialized training courses in space technology is often compromised by the reality that after receiving training, university educators in many least developed countries lack access to "seed" financial support for undertaking practical demonstration exercises to highlight the operational utility of space technology in solving local problems. The aim of TOPS would be to provide such university educators with access to limited financial and technical support (not exceeding $10,000 per grant) for the local implementation of practical activities relating to space technology that would serve to enhance the learning experience of their students.

278. TOPS would be aimed initially at the network of university educators from least developed countries in all regions who have participated in specialized space technology training courses (such as the United Nations international training course on remote sensing education for educators) or from the regional centres for space science and technology education. TOPS would also maintain a site on the World Wide Web through which educators could establish contact with each other to share experiences, with technical advisors on space technology issues and with institutions that are willing to assist or otherwise participate in the space technology demonstration activities being carried out by members of the network. Access to support under TOPS would be through applications from university educators to be selected according to merit on a competitive regional basis. The estimated annual cost of TOPS to Member States, through the United Nations, would be approximately $200,000 (corresponding to 20 awards of $10,000 each).

279. The Office for Outer Space Affairs should include among the priority activities of the United Nations Programme on Space Applications an activity aimed at assisting developing countries in obtaining funding for project proposals arising from its training courses and workshops. The projects to be selected would be those which could lead to sustainable use and development of space technology at the local level. Such an activity would entail, among other things, initial assessments of proposals and guidance on their preparation, the provision of information on potential funding sources and the requisite procedures for submission of applications and, where appropriate, direct submission by the Office of one or more proposals to specific funding or donor institutions. The costs involved for the United Nations could be covered within the existing resources of the Office.

H. Promotion of international cooperation

1. Use of space technology in the United Nations system

280. Various organizations within the United Nations system contribute to promoting international cooperation in the use of space technology and its applications. Valuable space-related and space-aided activities are being carried out in fields relating to remote sensing and GIS, communications and navigation, meteorology and hydrology, space science, improvement of safety and natural disaster reduction. Those activities range from education and training to operational applications of technologies. The Secretary-General's annual report on the coordination of outer space activities within the United Nations system provides details of the space-related activities planned by the organizations within the system for the coming two years. Paragraphs 281 to 301 below provide a summary and an analysis of the information provided in the Secretary-General's report of 19 May 1998 on the programme of work for 1998 and 1999 and future years (A/AC.105/700).

281. Space-related activities within the United Nations system are carried out with the use of such space technologies as remote sensing satellites and communication satellites. Major objectives pursued by several

organizations in those space-related activities include: (a) advancement of Earth sciences; (b) protection of the environment; (c) natural resource management; (d) disaster management; (e) improvement of satellite-based communications; and (f) improvement of navigation and positioning capabilities. Other important objectives relate to food security early warning, weather forecasting, urban planning, human settlement and monitoring of illicit crops. In order to meet those objectives, organizations conduct the following activities: (a) convening of intergovernmental meetings; (b) organization of training and educational programmes; (c) provision of technical advisory services and implementation of pilot projects; and (d) dissemination of information.

282. Activities of the organizations have various specific purposes and take different approaches within their individual mandates. However, all the space-related activities carried out with the United Nations system are aimed at achieving the overarching goal of promoting sustainable development, in particular in developing parts of the world.

Advancement of Earth sciences

283. Many organizations consider it essential to ensure the availability of scientific data on various aspects of the Earth in order to enhance the planning and execution of socio-economic development activities. This is one of the areas in which efforts are being strengthened in order to coordinate activities within the system. The Office for Outer Space Affairs, the Economic and Social Commission for Asia and the Pacific (ESCAP), UNEP, FAO, UNESCO and WMO participate in the work of CEOS, as its affiliate members, and contribute to the development of IGOS. Inter-agency cooperation and coordination is also considered crucial in the planning and operation of three global observation systems, namely GCOS, GOOS and GTOS.[7] In order to conduct joint consideration of space components for the three global observation systems, UNEP, FAO, UNESCO and WMO contribute to the work of the Global Observing Systems Space Panel.

284. WMO acts as a focal point for international efforts to improve the acquisition of data for climate and atmospheric research and for meteorology and hydrology. Its activities include the implementation and coordination of World Weather Watch, Global Atmosphere Watch, the World Climate Data Information Referral Service (INFOCLIMA), the World Hydrological Cycle Observing System, and the World Climate Programme.[8] ESCAP, FAO and UNESCO also assist developing countries in building capacity in the field of meteorology and hydrology. Some activities are carried out in other disciplines of Earth sciences, such as the Geological Applications of Remote Sensing (GARS) programme of UNESCO.

Protection of the environment

285. Many bodies, including the Economic Commission for Africa (ECA), ESCAP, the Economic and Social Commission for Western Asia (ESCWA), UNEP, the United Nation Institute for Training and Research (UNITAR), FAO, UNESCO and WMO, contribute to the monitoring and protection of the environment.

286. UNEP has wide-ranging and comprehensive activities aimed at the development and enhancement of environment information systems, capacity-building in environmental assessment and reporting on the status of the environment, protection of the coastal and marine environment, promotion of the use of environmental data for agricultural development, preservation of biodiversity and prevention and resolution of environmental conflicts. Those activities of UNEP are carried out through its Global Resource Information Database (GRID) centres, Environmental and Natural Resource Information Networks (ENRIN), Environmental Information Systems and the International Environment Information System (INFOTERRA), to name a few.

287. FAO is another organization active in the protection of the environment, in particular in Africa, where it carries out activities through ARTEMIS (see para. 109), Forest Assessment and Monitoring Environment (FAME) and the Regional Environmental Information Management Project (REIMP) for central Africa. The

Digital Land Cover Database for Africa (AFRICOVER) was initiated by the Inter-Agency Meeting on Outer Space Activities as an inter-agency project and FAO activities relating to AFRICOVER contribute to capacity-building of local institutions and authorities in protection of the environment.

288. While various specific objectives are pursued by the United Nations system within the context of protection of the environment, objectives to solve problems of regional and global significance are stressed and pursued more than others with the use of space technologies. Examples include the monitoring of land degradation, drought and desertification, pursued by ECA, ESCWA, UNEP, FAO and UNITAR, through its Desertification Information Systems, protection of coastal and marine environments, by UNEP, UNESCO and WMO, and the preservation of biodiversity, by UNEP, FAO and UNESCO, in particular through its Man and the Biosphere (MAB) programme.

Natural resources management

289. Many projects relating to the protection of the environment are also aimed at improving the management of natural resources. Examples of such projects are AFRICOVER, FAME and Forest Resources Assessment of FAO, ENRIN and GRID activities of UNEP and MAB of UNESCO. Within the framework of MAB activities, UNESCO cooperates with UNEP in the area of forest management. In the area of land resource management, UNEP cooperates with FAO in improving its Global Soil and Terrain Database (SOTER).

290. FAO carries out comprehensive space-related operational activities in the management of natural resources. Its activities concern the management of land, forest resources, marine/ocean, coastal zone and water resources. More bodies are carrying out activities in land resource management than any other aspect of natural resource management: ECA, ESCAP, UNEP and FAO all conduct technical advisory services in the area. ECA in particular focuses its activities on land management, through the development of land information systems and land cover mapping and its activities are supported by FAO, specifically through AFRICOVER.

Disaster management

291. Disaster management is another area in which many organizations carry out space-related activities. Those concerned with disaster management include the Office for Outer Space Affairs, the secretariat of the International Decade for Natural Disaster Reduction, ESCAP, UNESCO, the International Civil Aviation Organization (ICAO), ITU and the International Maritime Organization (IMO). While both remote sensing satellites and communications satellites are useful in enhancing disaster management, ITU focuses on the use of communications satellites for disaster communications, in cooperation with the secretariat of the International Decade for Natural Disaster Reduction and IMO. The WMO World Weather Watch combines both meteorological satellites and telecommunication facilities and includes a tropical cyclone programme and an emergency response activities programme, helping to ensure the provision of satellite data and products for natural disaster warning, mitigation and relief. UNESCO activities, such as those of GARS, focus rather on the use of remote sensing and GIS technologies in providing information on natural hazards of geological origin. In the case of ESCAP, activities in the area of disaster management relate to the use of meteorological satellites.

292. While the secretariat of the International Decade for Natural Disaster Reduction currently has no space-related operational activities, it acts as the focal point for international efforts to enhance disaster management. It is responsible for implementing recommendations of the World Conference on Natural Disaster Reduction, held at Yokohama, Japan, from 23 to 27 May 1994, such as the establishment and improvement of international disaster early warning systems. Through scientific and technical meetings organized by the secretariat of the Decade in connection with its conclusion, the use of remote sensing and communications satellites is being considered.

Improvement of satellite-based communications

293. In order to improve various satellite-based communications, ITU conducts extensive activities, including training and educational activities, technical advisory services and implementation of pilot projects, dissemination of publications and organization of intergovernmental meetings, such as the World Radiocommunication Conference, the World Telecommunication Development Conference and the World Telecommunication Policy Forum. ITU activities cover such issues as technical and regulatory aspects of telecommunications, radiocommunications and mobile satellite communications, in particular the use of the geostationary satellite orbit, as well as the use of communication satellites for the development of rural and remote areas and for distance education.

294. As regards the use of satellites for the development of rural and remote areas, ESCAP organizes training and educational activities, while ECA disseminates relevant publications. As for distance education, UNESCO, in cooperation with ITU, is implementing a pilot project to support primary teachers in developing countries and is establishing a satellite-based network in selected countries. ESCAP is also conducting a study project with special focus on satellite-based education. The establishment of satellite-based information networks for various purposes is pursued by the Office for Outer Space Affairs, through its cooperative information network linking scientists, educators, professionals and decision makers in Africa (COPINE), whose objective is to enhance information exchange in Africa; UNEP, through its Mercure project, UNEPnet and INFOTERRA, to enhance various aspects of environmental information management; and by UNESCO, through its African Network for Integration and Development (RAPIDE), to ensure the strong presence of Africa on the Internet.

295. Combined with the use of communication satellite technology, the use of information technology is also stressed by such entities as the Office for Outer Space Affairs, ECA, ESCAP, UNEP, UNITAR, FAO and UNESCO, in order to improve information management and to develop sound information infrastructures.

Improvement of navigation and positioning capabilities

296. The importance of satellite-based technologies for navigation and positioning is widely recognized within the United Nations system. ICAO promotes the introduction of satellite-based technologies for communication, navigation and surveillance elements in support of global air traffic management. ICAO also considers legal aspects of the implementation of such surveillance, including the establishment of a legal framework for the Global Navigation Satellite System. Maritime policy for the System is dealt with by IMO. ICAO and IMO cooperate to promote multi-modal use of the System in order to ensure that the services provided meet the needs of both maritime users and the aviation community.

297. IMO also cooperates with ITU in developing maritime radiocommunication services, including the Global Maritime Distress and Safety System. The WMO marine broadcast system also contributes to the implementation of the Global Maritime Distress and Safety System, the development of which is pursued by IMO in close cooperation with ITU, WMO, the International Hydrographic Organization, INMARSAT and COSPAS-SARSAT. ITU is also examining characteristics of satellite emergency position-indicating radio beacon (EPIRB) systems in relation to emerging rescue operations.

Other important applications of space technologies

298. Space technology and its applications are utilized in implementing pilot projects for various other development purposes. FAO, for example, provides information on food security early warning through its Global Information and Early Warning System (GIEWS), the Regional Famine Early Warning System and AFRICOVER. The GIEWS also contributes to agricultural development and management. ECA cooperates with FAO in implementing those systems in the African region.

299. FAO also utilizes remote sensing satellite technology for fishery management, disease control, through its Emergency Prevention System for Transboundary Animal and Plant Pests and Diseases (EMPRES), detection of locust areas, by the Reconnaissance and Management System of the Environment of Schistocerca (RAMSES) and AFRICOVER, and monitoring of illicit crops. FAO cooperates with the United Nations International Drug Control Programme on pilot projects to determine the location of narcotic crop cultivation sites using satellite remote sensing data. The Office for Outer Space Affairs also provides technical advisory services to the United Nations International Drug Control Programme in developing and implementing a system to monitor illicit cultivation of coca and opium poppy.

300. WMO has been the lead organization in enhancing weather forecast services by the use of meteorological satellites. Within the framework of its World Weather Watch, the Organization continues its efforts to ensure that every country has access to the information it needs in order to provide weather services on a day-to-day basis as well as for longer-term planning and research. The activities relating to meteorological services also contribute to the safety of air and sea traffic. In cooperation with the Intergovernmenetal Oceanographic Commission (IOC), WMO continues to improve the dissemination of meteorological and oceanographic data and information to ships at sea. WMO also collaborates with ICAO in developing and implementing the World Area Forecast System, which supplies information on aeronautical meteorological forecasts in support of commercial aviation.

301. Some other uses of space technology and its applications, considered for or already incorporated into pilot projects and studies relating to economic and social development, concern urban planning by ESCWA, establishment of a database on population by UNEP through its GRID activities and establishment of urban information systems by UNITAR. UNEP contributes to United Nations efforts in refugee settlement by means of its database pertaining to contingency planning for the areas around the refugee camps. FAO is also developing a Programme Management Information System (ProMIS) to provide information relating to planning, coordination implementation, monitoring and evaluation of humanitarian, emergency and development assistance programmes, in support of the work of the United Nations Office for the Coordination of Humanitarian Assistance and UNDP. UNESCO implements a space archaeology programme, in which remote sensing satellite technology assists field research activities on archaeological sites. UNESCO also continues to monitor selected cultural sites and historical cities with the use of remote sensing and GIS technologies.

2. International space law

(a) Status: international space law

302. International space law as developed by the United Nations through the Committee on the Peaceful Uses of Outer Space and its Legal Subcommittee reflects the importance that the world community attaches to international cooperation in the exploration and use of outer space. So far, five treaties and five sets of legal principles on matters relating to the peaceful uses of outer space have been drawn up through the United Nations, establishing a sound legal regime governing space-related activities.

303. The international legal principles in the five treaties[9] have established outer space as the province of all humankind, not subject to national appropriation, and have ensured freedom of exploration. They have banned the placement and use of nuclear weapons in outer space and provided for liability for damage caused by space objects, the safety and rescue of spacecraft and astronauts, the prevention of harmful interference in space activities, the avoidance of harmful contamination of celestial bodies and adverse changes in the environment of the Earth, the notification of space activities, the registration of objects launched into outer space, scientific investigation and the exploitation of natural resources in outer space, as well as the settlement of disputes. Each of the treaties lays great stress on the notion that the province of outer space, the activities carried out there and

whatever benefits might accrue from them should be devoted to enhancing the well-being of all countries and humankind, and each includes elements based on the principle of promoting international cooperation in outer space activities.

304. The five declarations and sets of legal principles[10] adopted by the General Assembly provide for the application of international law and the promotion of international cooperation and understanding in space activities, the dissemination and exchange of information through transnational direct television broadcasting via satellite and the sharing of data and information from satellite observations of Earth's resources, and general standards regulating the safe use of nuclear power sources necessary for the exploration and use of outer space.

305. The Committee on the Peaceful Uses of Outer Space and its Legal Subcommittee are currently considering the question of the review and possible revision of the principles relevant to the use of nuclear power sources in outer space; matters relating to the definition and delimitation of outer space and to the character and utilization of the geostationary orbit, including consideration of ways and means to ensure the rational and equitable use of the geostationary orbit, without prejudice to the role of ITU; and a review of the status of the five international legal instruments governing outer space.

306. Other intergovernmental organizations, in particular those of the United Nations system, are also contributing to the legal regime governing international cooperative space activities. Among them are ITU, WIPO, WMO and the International Atomic Energy Agency (IAEA). In addition, multilateral and bilateral treaties and agreements have secured the establishment and operation of international and regional space organizations and bodies such as ESA, the International Telecommunications Satellite Organization, the Arab Satellite Communications Organization, the European Organization for the Exploitation of Meteorological Satellites and the International Organization of Space Communications; and the development of cooperative programmes such as the Council on International Cooperation in the Study and Utilization of Outer Space, the COSPAS-SARSAT search and rescue satellite system and the International Space Station. Many individual States have also added to the corpus of space law through the adoption of national laws governing their activities in outer space and their goals for international cooperative ventures.

(b) Issues and objectives

307. The United Nations has succeeded in progressively developing and elaborating, in the form of treaties and declarations, a body of principles relating to space activities sufficient to be considered a separate branch of international law. In recent years, the increase in space activities has given rise to new, highly technical issues such as space debris, the use of nuclear power sources in space and the reinforcing of intellectual property rights. Those subjects pose many challenging legal questions that call for creative and flexible solutions through international cooperation if international space law is to keep pace with the rapid advances in space technology and activities.

308. Innovations in space technology are also bringing activities geared towards the exploitation of natural resources in outer space and on the various celestial bodies within the realm of feasibility. In view of the apparent lack of international consensus on the principles embodied in the Moon Agreement, as shown by its relatively low level of ratification, it is likely that practical issues relating to the ownership of and equitable access to such resources will require further substantial consideration within the field of international law.

309. Since UNISPACE 82 (see paras. 21-27 above), the world has witnessed dramatic growth in the commercialization and privatization of space-related activities. That trend has led to significant increases in the number of non-state actors involved in the use, exploration and exploitation of outer space, as well as the number of different activities in which they are engaged. Satellite telecommunications, satellite navigation and positioning, the provision of launching equipment and services and remote sensing are already developing into

rapidly growing private industries. Similarly, activities such as space tourism, the mining of asteroids and other celestial bodies and waste disposal in outer space are no longer matters of idle speculation, but are being seriously considered as possibilities for private space enterprise in the not too distant future. The growing diversity of space-related activities may soon require extensive intergovernmental regulatory cooperation and the elaboration of common legal rules, standards and practices to ensure that space activities are carried out in a safe, systematic and orderly fashion.

310. A further pressing concern is the fact that many States have yet to ratify or sign the various legal instruments governing space-related activities that have been elaborated within the framework of the United Nations. Despite annual resolutions by the General Assembly inviting States to consider ratification or accession to the treaties, the apparent decline in the willingness of States to bind themselves to the terms of successive treaties[11] tends to undermine the normative authority of the later international agreements. The Committee on the Peaceful Uses of Outer Space and its Legal Subcommittee have solicited the views of States regarding the obstacles that impede ratification of the five international legal instruments governing outer space[12] and have begun a review of those legal instruments with a view to initiating discussion on the situation. The exercise has also drawn attention to the fact that actual adherence in practice by States to the provisions of the treaties to which they are parties is less than optimal, itself a matter requiring immediate consideration.

311. The role of the Committee on the Peaceful Uses of Outer Space and its Legal Subcommittee as mechanisms for the elaboration of appropriate rules and principles regulating outer space needs to be strengthened in order to meet the requirements of a rapidly advancing field of human activity. This might entail consideration by them of such issues as those already suggested by Member States for inclusion in the agenda of the Legal Subcommittee: commercial aspects of space activities (e.g. property rights, insurance and liability); legal aspects of space debris and review of existing norms of international law applicable to it; comparative review of the principles of international space law and international environmental law; review of some of the existing sets of principles on matters relating to the peaceful uses of outer space elaborated by the United Nations, with a view to the possible transformation of those texts into treaties; examination of the Agreement relating to the implementation of Part XI of the United Nations Convention on the Law of the Sea as a model to encourage wider accession to the Moon Agreement; and improvement of the Convention on Registration of Objects Launched into Outer Space.[13]

3. State and perspectives of international cooperation

(a) Status: international cooperation

312. The General Assembly, by its resolution 51/122, adopted the Declaration on International Cooperation in the Exploration and Use of Outer Space for the Benefit and in the Interest of All States, Taking into Particular Account the Needs of Developing Countries. The adoption of the Declaration not only marked another achievement by the United Nations in the development of the international legal regime governing space activities, but also reaffirmed the commitment of Member States to promoting international cooperation in the peaceful uses of outer space for the benefit of all countries.

313. The fading away of cold war tensions during the past decade has dramatically altered the way in which the space-faring countries of the world conduct space activities. Valuable resources that were once subject to rival strategic considerations may now be used to foster greater cooperation. The rapidly changing world economic landscape has provided the context and impetus for closer cooperation between States moved by a new sense of urgency about long-neglected global problems. As a result, international cooperation has created a mindset whereby all those involved in space activities have come to recognize both the advantages of working together to identify common goals and the need to optimize existing resources, financial and otherwise.

314. On the other hand, obstacles remain in the way of increased international cooperation—budgetary restraints for space programmes in major space-faring countries and the difficulty for developing countries to identify and join existing cooperation programmes. It has thus never been more critical in the history of the space age to stimulate and encourage international cooperation.

315. Conserving the environment, the advent of the information age and continued exploration of the solar system are just some of the important global issues in relation to which space technology can play a leading role in the coming years and many multilateral mechanisms already exist to promote greater international cooperation, in particular with a view to assisting developing countries. Other activities may require the creation of such mechanisms, but there are a multitude of obstacles preventing greater cooperation. Without continued efforts at international cooperation, however, smaller and developing countries may never build up an adequate scientific and educational base for sustainable space technology and application programmes. Many national space activities, such as satellite communications and broadcasting, require international coordination in order to function successfully.

316. In order to enhance international cooperation, consideration should be given to further strengthening successful mechanisms for cooperation that already exist, such as intergovernmental mechanisms, quasi-governmental/private organizations,[14] ad hoc inter-agency mechanisms,[15] transnational industrial activities[16] and international non-governmental organizations. Intergovernmental mechanisms include bilateral cooperation, currently taking place between developing countries,[17] and multilateral cooperation, involving intergovernmental mechanisms. The latter may take various forms, including the establishment of a permanent institutional mechanism, such as the Committee on the Peaceful Uses of Outer Space and ESA, the establishment of an ad hoc mechanism, such as the series of space conferences of the Americas held in Latin America and the Caribbean, and project-by-project cooperative mechanisms, such as the International Space Station.

317. Many space-faring countries are also conducting technical assistance programmes, studies and seminars, either on a bilateral or a regional basis. While international efforts should continue to be made to explore new and innovative mechanisms for cooperation that would best meet the needs of participating countries, some of the successful mechanisms should be further promoted. It is also important for assistance programmes to be coordinated so that they complement each other. It is crucial for each country to have the best possible portfolio of options for international cooperation in order to maximize scientific and technological, economic and social, as well as industrial, returns from space activities.

(b) Issues and concerns

318. As with many other instances of technology transfer and cooperative projects, a primary issue is that the recipient should have the capability to sustain or maintain the technology long after the donor has gone. Educating and training scientists and others in the user community is essential to ensuring that the technology is used to its fullest extent.

319. Environmental monitoring appears to be the most promising discipline for the pursuit of greater international cooperation. It is now universally accepted that Earth is a unified system, with events in one area of the planet potentially affecting another. Thus, it is currently beyond the resources of any single agency or country to undertake the comprehensive programmes required to understand the science of the Earth's system in all its aspects. In addition, objective scientific data are required in order to make sound decisions and credibility depends on international participation in the scientific process.

320. The growing role of private industry in space activities and the parallel decline in government funding for space programmes are aspects of another issue reflecting overall economic trends. In that connection, it is

important to recognize the private sector as a potential partner in future activities by identifying projects that could possibly benefit from its participation and to encourage its involvement.

321. Greater involvement of the private sector is linked to the cost factor of many space activities, which consists of two elements: firstly, the cost of acquiring the necessary data or technology and, secondly, the cost of pursuing the space activities themselves. For most developing countries, the mere acquisition of expensive data sets is an insurmountable barrier to greater participation in space activities. As more private firms begin to offer data provision services, market forces should drive down costs and make the data more widely affordable.

322. In terms of project costs, especially for large, human space exploration missions, a single country can no longer pay such a huge bill. The International Space Station provides an example of 15 States pooling resources to share the technological and financial burdens of a project that will have wide-ranging benefits for all humanity.

323. Another issue to be overcome for there to be increased participation in international cooperation activities by developing countries is their occasional reluctance to participate in such activities as a result of lack of confidence in their ability to act as equal partners in terms of know-how and technical capabilities. International cooperative schemes in this field should therefore put more focus on promoting capacity-building in human resources on the part of developing countries.

324. As discussed in paragraphs 280 to 301 above, space applications activities are conducted for development purposes by various organizations of the United Nations system. Such activities are coordinated by the Inter-Agency Meeting on Outer Space Activities in order to avoid unnecessary duplication in planning future endeavours and to explore possibilities of carrying out ongoing and planned activities through joint inter-agency efforts. However, the current inter-agency mechanism is limited in what it can do to coordinate activities, in particular those already approved by the States members of the organizations concerned, if the coordination involves changes in the mandated activities.

(c) Specific action programmes

325. Support for various programmes is often dependent upon how much and what type of information about them is available. In a number of countries, there is a lack of information among both the population at large and government leaders about the practical benefits of many space technologies. Better information about those benefits would probably increase the level of interest in making more extensive use of space technology applications in development programmes. To that end, the space community of space-faring countries should stress the value of international cooperation to obtain the practical benefits of space technology in support of sustainable development.

326. In order to increase political support for international cooperation in space activities, there should be a multilateral political consensus to implement common space goals, identified, *inter alia*, by the General Assembly in its resolution 51/122, at the highest decision-making level. To that end, consideration should be given to strengthening the efforts to include a space item on the agenda of a multilateral meeting of heads of State.[18] A similar approach could be also taken to increase political support for international cooperation among legislators. Consideration could be given to convening ad hoc multilateral meetings of legislators who are advocates of space activities to discuss common goals to be pursued in space endeavours.

327. In order to take full advantage of the applications of space technology, developing countries need to acquire expertise of their own. With this in mind, educational and training activities should be strengthened and

supported by bilateral and multilateral programmes, such as the regional training centres for space science and technology education established with the assistance of the United Nations.

328. Appropriate existing international mechanisms should be used to explore the further development of space technology applications that have a high potential for success and that contribute to meeting global needs. Where such a mechanism does not exist, one should be established and consideration given to new forms of cooperation. Such applications include but are not limited to the following:

(a) Cooperative telecommunications efforts, especially those of benefit to developing countries, using existing facilities and satellite capabilities;

(b) A disaster mitigation system, using scientific, Earth observation, data collection and mapping satellites coupled with a near-real-time data fusion and distribution system;

(c) A commercially sustainable Earth observation system.

329. National space agencies should share information with each other on their processes for selecting and funding prospective space science projects, thus removing an impediment to expanded space science research. Where feasible, the conception and execution of joint projects between space-faring countries and developing countries should be encouraged and facilitated.

330. The existing mechanisms are still limited in their ability to define and coordinate the needs of the user community in Earth environmental monitoring activities. Accordingly, those mechanisms should be strengthened in order to facilitate the coordination of needs in that field between satellite operators and users with a view to providing, in a more effective manner, a unified set of data requirements to help in designing and operating future Earth observation systems.

331. The role of the United Nations in promoting international cooperation in the peaceful uses of outer space could be further enhanced by the following actions:

(a) Enrichment of the work of the Scientific and Technical Subcommittee through:

  (i) Inclusion of the following issues in its work by expanding the scope of its consideration of some of the existing agenda items or adding new agenda items:

    a. Natural hazard early warning, prevention, mitigation and relief through the use of space technology and its applications;

    b. International cooperation on human space flight activities, including in-orbit research;

    c. International cooperation in global satellite navigation systems;

    d. Space commerce and its impact on science and the environment;

  (ii) Strengthening the partnership with industry by organizing during its annual session a one-day industry symposium to provide Member States with updated information on commercially available products and services and on ongoing activities of space-related industries and to offer opportunities to managers from space-related industries to express concerns and to make suggestions;

(b) Enrichment of the work of the Legal Subcommittee;

(c) Enhancement of the coordination of space activities within the United Nations system through:G34

(i) Establishment of an ad hoc intergovernmental advisory group, consisting of the chairmen of the intergovernmental bodies responsible for space-related activities of organizations of the system, to meet for one day to review inter-agency coordination and to inform the respective intergovernmental bodies of any substantial recommendations of the Inter-Agency Meeting on Space Activities;

(ii) More critical review of inter-agency coordination by the above-mentioned intergovernmental bodies in order to provide guidelines to assist secretariats responsible for implementing space activities in identifying areas in which coordination efforts should be strengthened;

(d) Strengthening of the outreach activities of the United Nations Programme on Space Applications through:

(i) Organization of an annual public forum, to be held in various countries and regions in collaboration with interested non-governmental organizations, to inform the general public of past, ongoing and planned space activities and the future direction of such activities. The programme would be developed by the Office for Outer Space Affairs in collaboration with non-governmental organizations and interested space agencies;

(ii) Invitations designed to encourage the participation of youth in activities of the Programme;

(iii) Promotion of interest in space science and technology among young scientists and engineers;

(iv) Establishment, in coordination with the Association of Space Explorers, of a programme of visits by astronauts and other space scientists and engineers with the aim of increasing knowledge about space-related activities, in particular among young people.

V. THE SPACE MILLENNIUM: VIENNA DECLARATION ON SPACE AND HUMAN DEVELOPMENT

[The text that follows corresponds to the text presented to the Working Group of the Whole of the Preparatory Committee during its session in June 1998, as contained in document A/CONF.184/CRP.7/Rev.1, and is still subject to modification at the 1999 session of the Advisory Committee.]

332. Humankind has always looked upon the Sun as the life-giver and at the star-filled night sky with wonder. Innate curiosity about the stars and the solar system first led to the science of astronomy. Centuries ago, astronomers initiated the study and set the stage for the understanding of the physical laws dictating the movement of celestial objects.

333. Today, the reach and scope of space systems transcend national boundaries in their fundamental characteristics. Space science and technology have played an important and visible role in many areas of human activity, including the following: fundamental knowledge of the universe, education, health, environmental monitoring, management of natural resources, meteorological forecasting and climate modelling and communication. They are thus a major contributor to the well-being of humanity and specifically to economic, social and cultural development.

334. Recognizing that the exploration and use of outer space should be the province of all humankind and that there is need for a global dialogue on space-related issues, the United Nations organized space conferences in Vienna in 1968 and in 1982. Those conferences led to many new initiatives, including the creation of the United Nations Programme on Space Applications and the establishment of regional centres for space science and technology education. These are contributing to the understanding of space technology and to capacity-building in the utilization of space technology at the local level for social and economic development.

335. Since the holding of the Second United Nations Conference on the Exploration and Peaceful Uses of Outer Space (UNISPACE 82), significant changes have occurred in the structure and content of world space activity. The fading away of cold-war tensions and the considerable increase in the number of participants in space activities have led to a sharp rise in levels of international cooperation and to the growing realization that space can address common concerns. Another important trend is the growing role of the private sector in the definition and implementation of space activities, often in partnership with Governments.

336. As humanity approaches the new millennium, it is faced with new and unprecedented challenges to its sustainable development, such as pollution of the environment, depletion of natural resources, loss of biodiversity and the effects of natural and anthropogenic disasters. Meeting those challenges requires international cooperation and the tools of space technology, including appropriate communication infrastructure. Today, space activity has the potential to become a global economic engine in the twenty-first century.

337. It is the view of the Conference that those challenges can be met by strengthening international cooperation in the peaceful exploration and use of outer space on the basis of mutual consideration of the interests of all parties, through the sharing of space knowledge and resources, coordination of missions and the facilitation of joint projects. In particular, efforts should be undertaken to facilitate substantive joint projects between space-faring and non-space-faring countries as well as among developing countries, which could result in the undertaking of projects that are beyond the means of individual countries.

338. Taking the above into consideration, the following list of actions constitutes the nucleus of a strategy to address global challenges in the future:

(a) Implement a worldwide environmental watch system, building on the important efforts of various entities and organizations involved in that area, with a view to maximizing existing coordination and capabilities;

(b) Increase and facilitate the use of remote sensing data in the management of natural resources, in particular through the coordination of remote sensing systems and improved access to and affordability of data;

(c) Strive towards the establishment of a global space-based disaster management system for monitoring and predicting natural disasters such as forest fires, floods, tropical cyclones, droughts and volcanic eruptions and mitigating their impact. The system should promote optimal use of existing and planned resources in space technology worldwide;

(d) Develop and improve satellite-related infrastructures and appropriate educational programmes to help eradicate illiteracy and enhance rural education;

(e) Improve public health services through a wide use of space-based services, such as telemedicine, and in the control of vector-borne diseases;

(f) Promote universal access to space-based telecommunications and, in the process, enhance opportunities for knowledge-sharing, through the development of appropriate policies and the necessary infrastructures and through projects that will support relevant applications;

(g) Assist the capacity-building process in developing countries in order to facilitate their participation in space research and utilization of the resulting benefits, with emphasis on the development and transfer of knowledge and skills, and the establishment of appropriate infrastructure. The regional centres for space science and technology education being established at the initiative of the United Nations should be the nucleus for such efforts, with sustaining funding mechanisms;

(h) Promote the widest possible use of satellite-based navigation and position/location systems, in particular in the fields of transport, search and rescue, geodesy and geographic information systems, by paving the way towards universal access to and compatibility of such systems;

(i) Promote cooperative activities to further humanity's knowledge of outer space in such fields as astronomy, space biology and medicine, space physics and planetary research and exploration, with special attention to near-Earth objects;

(j) Reaffirm the role of the Committee on the Peaceful Uses of Outer Space, as well as its two subcommittees, and support for its secretariat in the promotion of the peaceful uses of outer space;

(k) Enhance support for the United Nations Programme on Space Applications by providing it with adequate resources;

(l) Encourage the increased use of space-related systems and services by the specialized agencies of the United Nations;

(m) Encourage all countries throughout the world to provide their youth with opportunities to learn more about space science and technology and their importance to human development and to participate actively in space-related activities, as an investment in the future;

(n) Encourage efforts aimed at the protection of the outer space environment, in particular through further research in and implementation of mitigation measures for space debris;

(o) Recognizing the significant economic spin-offs that have been generated by investment in space science and technology to date, encourage the optimized sharing of information on and opportunities connected with such spin-off activities, in particular between industrialized and developing countries;

(p) Invite all nations that have not yet done so to sign and ratify the five space treaties, and also invite intergovernmental organizations involved in space activities that have not done so to declare their acceptance of those treaties;

(q) Further progressively develop international space law as a basis for international cooperation in space activities for peaceful purposes;

(r) Support the implementation of an integrated global observing strategy and promote the use of Earth observation data by facilitating access to such data;

(s) Promote the establishment of information infrastructures with the use of appropriate space technologies and the adoption of common standards, distributed networks and common user interfaces;

(t) Encourage the private sector to join the United Nations efforts in promoting the peaceful uses of outer space;

(u) Increase awareness among policy and decision makers as well as the general public of the importance of the exploration and use of outer space for the advancement of economic and social conditions;

(v)-(...)

[To be completed with inputs from the regional preparatory conferences and other sources.]

339. UNISPACE III, taking cognizance of the new international context, recognizes the vital importance of the goals enumerated above and described in detail in its report. It notes that sustainable development, in all its facets, will require the attainment of those goals within a reasonable time-frame and that space technology and its applications will be a major contributor to ensuring the overall well-being of planet Earth and the development—even survival—of humanity.

Notes

[1] The original members were: Albania, Argentina, Australia, Austria, Belgium, Brazil, Bulgaria, Canada, Czechoslovakia (succeeded by the Czech Republic), France, Hungary, India, Iran (Islamic Republic of), Italy, Japan, Lebanon, Mexico, Poland, Romania, Sweden, Union of Soviet Socialist Republics (succeeded by the Russian Federation), United Arab Republic (former name of Egypt), United Kingdom of Great Britain and Northern Ireland and United States of America. The membership was enlarged to 28 in 1961 (by admitting Chad, Mongolia, Morocco and Sierra Leone), to 37 in 1973 (by admitting Chile, the German Democratic Republic, Germany, Federal Republic of, Indonesia, Kenya, Nigeria, Pakistan, the Sudan and Venezuela), to 47 in 1977 (by admitting Benin, Cameroon, Colombia, Ecuador, Iraq, the Netherlands, the Niger, the Philippines, Turkey and Yugoslavia) and to 53 in 1980 (by admitting China, Greece, Portugal, Spain, the Syrian Arab Republic, Upper Volta (former name of Burkina Faso), Uruguay and Viet Nam). As part of the 1980 expansion, Spain and Greece were admitted on the understanding that they would alternate every three years with Portugal and Turkey, respectively. In 1990, the Ukraine was appointed a member of the Committee to fill the vacancy brought about by the accession of the German Democratic Republic to the Federal Republic of Germany. The current membership of 61 was constituted in 1994 (by admitting Cuba, Kazakhstan, Nicaragua, the Republic of Korea, Senegal and South Africa, the

German Democratic Republic and Germany, Federal Republic of, having been succeeded by Germany). The practice of rotating membership between Greece and Turkey as well as between Portugal and Spain was terminated as part of the 1994 expansion, and Cuba and the Republic of Korea were admitted on the understanding that they would alternate every two years with Peru and Malaysia, respectively.

[2] The bureaux consist of the Chairman, First Vice-Chairman and Second Vice-Chairman/Rapporteur of the Committee; the Chairman of the Legal Subcommittee; and the Chairman of the Scientific and Technical Subcommittee. Currently, U. R. Rao (India), Raimundo Gonzalez (Chile) and [...] serve as the Chairman, the First Vice-Chairman and the Second Vice-Chairman/Rapporteur of the Committee, respectively. The chairmen of the Scientific and Technical Subcommittee and the Legal Subcommittee are Dietrich Rex (Germany) and Václav Mikulka (Czech Republic), respectively.

[3] Following a request by the General Assembly, the small expert unit that had initially been established to render assistance to the Ad Hoc Committee on the Peaceful Uses of Outer Space became a unit within the Department of Political and Security Council Affairs in 1962 to service the Committee on the Peaceful Uses of Outer Space and its Scientific and Technical Subcommittee. It was transformed into the Outer Space Affairs Division of that Department in 1968 and then into the Office for Outer Space Affairs within the Department of Political Affairs in 1992. Since 1993, when the Office was transferred from New York to the United Nations Office at Vienna, it has also been servicing the Legal Subcommittee, which had previously been serviced by the Office of Legal Affairs.

[4] Kurt Waldheim (Austria) was elected President and Vikram A. Sarabhai (India) was elected Vice-President and Scientific Chairman of the Conference, which was attended by 78 Member States and 13 international organizations.

[5] Following his appointment in October 1980 by the Secretary-General of the United Nations, Yash Pal (India) took office as Secretary-General of the Conference in March 1981. The other senior members of the Conference secretariat, including the Executive Secretary, three deputy secretaries-general and three senior advisers, were appointed and took office in January 1982.

[6] Willibald Pahr (Austria) was elected President and Carlos Antonio Bettencourt Bueno (Brazil) was elected Rapporteur-General of the Conference.

[7] Secretariats of GCOS, GOOS and GTOS are located in WMO, the Intergovernmental Oceanographic Commission (IOC) of UNESCO and FAO, respectively.

[8] The World Climate Programme consists of four key components, the World Climate Research Programme, the World Climate Data and Monitoring Programme, the World Climate Applications and Services Programme and the World Climate Impact Assessment and Response Strategies Programme. UNEP is responsible for the implementation of the latter, while the World Climate Research Programme is implemented jointly by WMO, IOC and ICSU.

[9] The five treaties and agreements are the Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies (the "Outer Space Treaty"), adopted on 19 December 1966, opened for signature on 27 January 1967, entered into force on 10 October 1967, 94 ratifications and 27 signatures; the Agreement on the Rescue of Astronauts, the Return of Astronauts and the Return of Objects Launched into Outer Space (the "Rescue Agreement"), adopted on 19 December 1967, opened for signature on 22 April 1968, entered into force on 3 December 1968, 83 ratifications and 25 signatures; the Convention on International Liability for Damage Caused by Space Objects (the "Liability Convention"), adopted on 29 November 1971, opened for signature on 29 March 1972, entered into force on 1 September 1972, 76 ratifications and 25 signatures; the Convention on Registration of Objects Launched into Outer Space (the "Registration Convention"), adopted on 12 November 1974, opened for signature on 14 January 1975, entered into force on 15 September 1976, 39 ratifications and 4 signatures; and the Agreement Governing the Activities of States on the Moon and Other Celestial Bodies (the "Moon Agreement"), adopted on 5 December 1979, opened for signature on 18 December 1979, entered into force on 11 July 1984, 9 ratifications and 5 signatures.

[10] The five declarations and legal principles are the Declaration of Legal Principles Governing the Activities of States in the Exploration and Use of Outer Space, General Assembly resolution 1962 (XVIII) of 13 December 1963; the Principles Governing the Use by States of Artificial Earth Satellites for International Direct Television Broadcasting, resolution 37/92, annex, of 10 December 1982; the Principles Relating to Remote Sensing of the Earth from Outer Space, resolution 41/65,

annex, of 3 December 1986; the Principles Relevant to the Use of Nuclear Power Sources in Outer Space, resolution 47/68 of 14 December 1992; and the Declaration on International Cooperation in the Exploration and Use of Outer Space for the Benefit and in the Interest of All States, Taking into Particular Account the Needs of Developing Countries, resolution 51/122, annex, of 13 December 1996.

[11] For example, the 1979 Moon Agreement has been ratified by only 9 States and signed by an additional 5 States, as opposed to the Outer Space Treaty of 1967, which has been ratified by 94 States and signed by an additional 27 States.

[12] The views received from Member States in that regard can be found in the note by the Secretariat of 2 March 1998 (A/AC.105/C.2/L.210 and Add.1).

[13] These proposals can be found in the report of the Legal Committee on the work of its thirty-seventh session (A/AC.105/698), paras. 67-69.

[14] Quasi-governmental/private organizations are those which may involve some or substantial governmental ownership or other influence, but which operate in accordance with business principles. An example of such organizations is INTELSAT. The European Organization for the Exploitation of Meteorological Satellites (EUMETSAT), EUTELSAT, INMARSAT and the International Organization of Space Communications (INTERSPUTNIK) are also modifications of the basic INTELSAT model.

[15] Examples include CEOS, the Inter-Agency Consultative Group for Space Science and the Space Agency Forum.

[16] There are various modes of transnational industrial cooperation, such as joint ventures, merger and acquisition, strategic or tactical alliances and foreign direct investment.

[17] A recent example is the cooperation between Brazil and China to develop remote sensing satellites.

[18] Precedents already exist for having space issues on the agenda of the summit meetings of the Group of Eight, resulting in the creation of a framework for political support for certain space activities. Earth observation issues were discussed at the summit held in 1982 at Versailles, giving birth to the activities of CEOS. The United States' invitation to participate in the space station programme was on the agenda of summit meetings held in 1984 in London and in 1985 at Bonn.